FOOD TECHNOLOGY

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Sixteenth Annual Meeting of IFT
June 10-14, 1956
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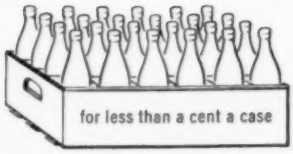

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IFT ACTIONS AND REACTIONS . . .

THE AGRICULTURAL RESEARCH INSTITUTE . . .

Notes on Annual Meeting

The Agricultural Research Institute held its Fourth Annual Meeting in Washington, D. C., October 17-18, 1955. According to Dr. Frank L. Gunderson, Liaison Representative of A.R.I., nearly a hundred research-minded men from agricultural industries, government, and universities exchanged views and heard stimulating reports of achievements and of problems requiring mutual effort. Many of these related to foods, especially in the agricultural production stages.

Dr. Heineman served as general chairman, while Dr. L. E. Clifcorn, IFT President, presided over the session on progress reports of the committees of The Agricultural Board. The Board's committees cover essentially these areas: agricultural equipment, agricultural pests, animal breeding and genetics, animal health, brucellosis and leptospirosis, animal nutrition in some eight or ten species categories, fats and oils, feed composition, preservation of indigenous strains of maize, and range and pasture problems.

The program included a challenging report by Professor A. G. Norman, Department of Botany, University of Michigan, entitled "The Strategy of Research;" an address, "The Farmer and the Future" by Ervin L. Peterson of the U. S. Department of Agriculture; and a Symposium on "Corn in the American Economy." A conference on Problems Involved in the Study, Evaluation, and Application of Pesticides was held under A.R.I. sponsorship in Washington on October 19. A review was made of the operations under the pesticide Public Law 518 as it bears on the work and planning of the FDA, of Land-Grant Colleges, and of the industries.

The Agriculture Research Institute was established in 1951 as a means of organizing the scientific talents of industry, public agencies, scientific societies, and private institutions in support of the National Academy of Sciences — National Research Council's Agricultural Board, and to provide a forum for unrestricted discussion of common problems.

Presidents of the A.R.I. have been, in turn: Dr. Roy C. Newton of Swift & Co.; Dr. Paul D. V. Manning of International Minerals and Chemical Corp.; and, Dr. H. E. O. Heineman of Pet Milk Company—all very active members of IFT.

Walter C. Dutton of the Dow Chemical Company is the 1956 President of the A.R.I. Max T. Goebel of DuPont was elected Vice President and Norman Kennedy of Corn Industries Research Foundation, Secretary. A.R.I. has two types of membership: Class A membership comprises industrial firms who each contribute $300.00 per year to help support the travel and subsistence expenses of members of the Agricultural Board, its committees and sub-committees to meetings, and to support the secretarial services. Class B members are exempt from dues, and include representatives of federal and state experiment stations and scientific and trade associations.

PERKIN CENTENNIAL 1856-1956 . . .

Commemorating the Discovery of Aniline Dyes

During 1956, the entire chemical world is paying tribute to William Henry Perkin, an inventive genius whose research-conscious mind was responsible for creating the first synthetic dye—known historically as Perkin's mauve. Perkins attempt to synthesize quinine and his efforts, insofar as his objective was concerned, were a failure; however, he did not let matters rest when he obtained some violet crystals instead of quinine. Rather he pursued his experiments until he was able to market his product.

His success spurred the desire to delve into the unknown world of synthetic color, and shortly thereafter others brought forth dyes that outrivalled nature's colors in virtually all respects. Man's dependence upon natural dyes was thus ended. From Perkin's simple color, mauve, the range of coal-tar dyes now numbers in the thousands, which provide the means to a richer, more beautiful, more colorful world.

Little did Perkin realize the tremendous impact his discovery would have upon the chemical industry. He could scarcely have foreseen the far-reaching effect it would have upon nations throughout the world and how the invention of a synthetically produced dye would result in the development of countless other chemicals and intermediates stemming from research in dyes. These have been used to synthesize many photographic chemicals, perfumes, flavorings and insecticides as well as pharmaceuticals, plastics, resins, surface-active agents, agricultural chemicals, textile fibers and other organic compounds that have become a part of modern life. The raw materials and intermediate chemicals used in dye manufacture have also provided a broad range of medicinal, petroleum and rubber chemicals.

A number of outstanding new commercial products that are not related chemically to dyes nevertheless owe their successful manufacture to engineering research and experience gained in the production of dyes. This is particularly true of synthetic rubber and tetraethyl lead. These offshoots of dye manufacture make their way into every avenue of commerce. They are part of an enormous and ever-growing stream of chemical inventions, many of which have given rise to complete industries in themselves.

The Centennial

The Centennial of Perkin's discovery will be climaxed by a celebration during the week of September 10, 1956, at the Waldorf-Astoria Hotel, New York City. The Observance is sponsored by the American Association of Textile Chemists and Colorists, directed by the Perkin Centennial Committee, and is considered to be of such import to leading technical, chemical and scientific

(Continued on page 6)

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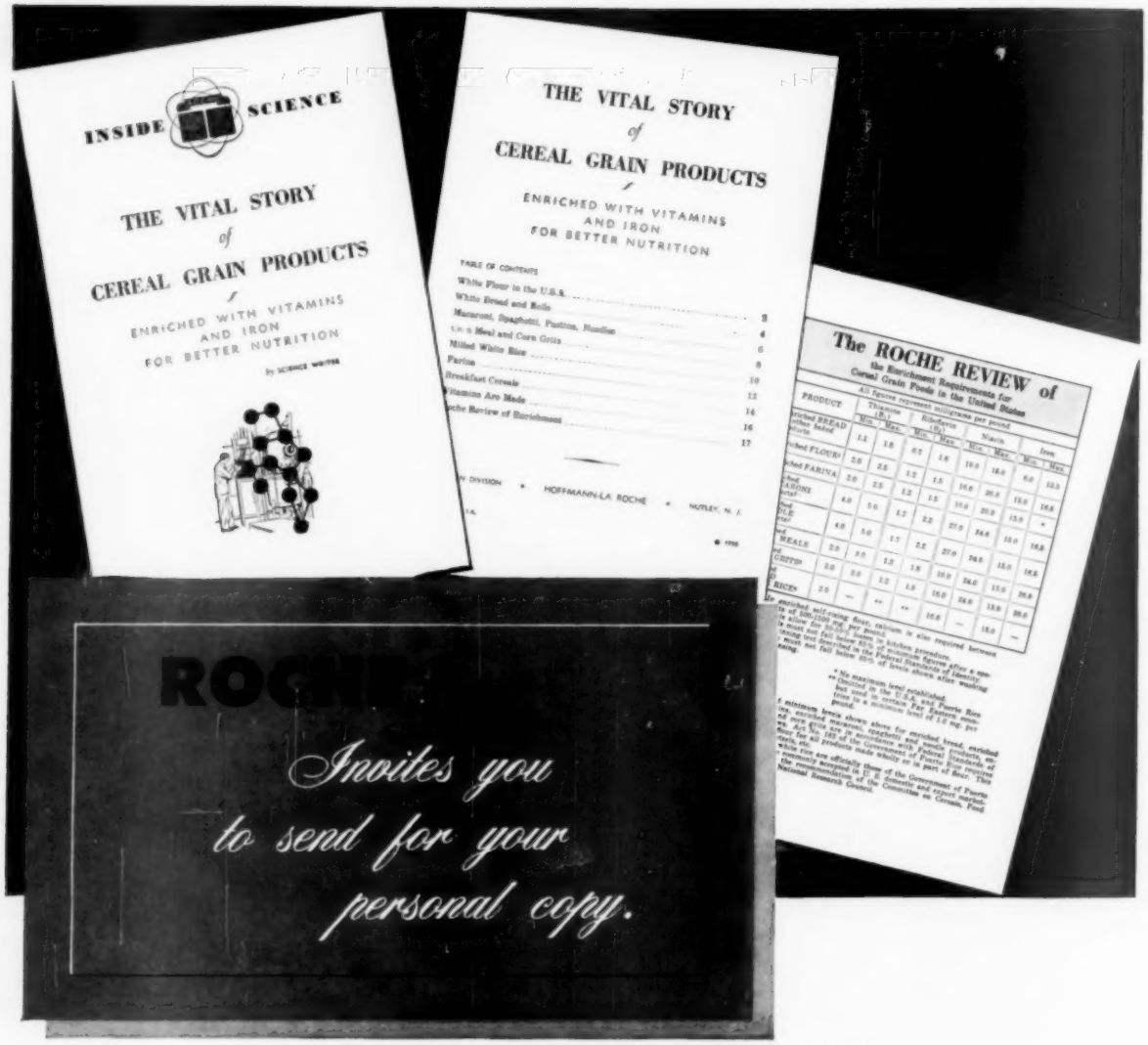
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(Continued from page 2)

societies concerned with the production or application of color that twenty-seven such organizations and two departments of the U. S. Government have signified their desire to participate in the occasion.

On Wednesday, September 12th, the Institute of Food Technologists will present a special scientific program under the chairmanship of Dr. B. E. Proctor, Professor and Head of the Department of Food Technology at M.I.T. The tentative program covers the following:

THE STRUCTURE AND PROPERTIES OF PRESENT DAY FOOD COLORS, by Dr. Samuel Zuckerman—Tech. Director, Brooklyn Div., H. Kohnstamm & Co., Inc.

SUGAR AND CHOCOLATE CANDIES by Philip Gott, President, National Confectioners' Association.

MEAT AND MEAT PRODUCTS by Henry Kraybill, Vice President and Director of Research and Education, American Meat Institute Foundation.

CEREALS AND BAKED PRODUCTS by William B. Bradley, Scientific Div., American Institute of Baking.

SIGNIFICANCE OF COLOR IN DAIRY PRODUCTS by Arnold A. Johnson, President, National Dairy Research Laboratories, Inc.

CITRUS PRODUCTS by Kenneth H. Klipstein, General Manager, Research Division, American Cyanamid Company.

PSYCHOLOGICAL ASPECTS OF FOOD COLORS FROM THE CONSUMER'S STANDPOINT by Dean Foster, Director of Laboratories, U. S. Testing Co., Inc.

HEARINGS ON FOOD ADDITIVE BILLS — MOST RECENT DEVELOPMENTS

Several new steps in food additives legislation have been taken since copy for "IFT Actions and Reactions" for the March issue of FOOD TECHNOLOGY went to press. As indicated in a footnote to that report, Commissioner George P. Larrick, Food and Drug Administration, and William W. Goodrich, Assistant General Counsel for Food and Drugs of the Department of Health, Education and Welfare testified on February 14th.

Prepared statements by Commissioner Larrick and Counsel Goodrich were heard by the Health and Science Subcommittee of the House of Representatives' Committee on Interstate and Foreign Commerce. Interrogation of the witnesses, according to regular practice, was limited to members of the Subcommitte under the Chairmanship of Representative Percy Priest.

The Hearing was concluded on that day with the exception that the committee may hear witnesses on the effect of radiation on foods. Pending that decision the Hearing Record (as of early April) is not available for distribution.

Commissioner Larrick and Counsel Goodrich emphasized the need for legislation and favored the Delaney Bill HR 4475. Dr. Larrick stated new legislation is needed" . . . first, to fill the gap in the present law which permits untested or inadequately tested chemicals to enter the food supply and second, to relax the present rule which flatly prohibits unnecessary or avoidable poisons in food." Dr. Larrick regards the prerequisite of "functional value" as relating to only the "chemicals that are not plainly harmless substances." He favors, also, a provision contained in some bills, permitting the Secretary to exempt additives for research purposes.

FDA's Counsel Goodrich declared very positively the Administration's preference "for solution of the questions of safety of new chemicals in food through the administrative process with review by the United States Courts of Appeals . . . ," (as provided in the Delaney Bill HR 4475). Also, Mr. Goodrich emphasized "We oppose both the declaratory judgment approach (as in the Priest-O'Hara Bills HR 8271 and 8275) and the injunction procedure" as in earlier O'Hara-Priest Bills.

Mr. Goodrich's firm views and presentation brought the only sharp exchange of the Hearing. Rep. O'Hara was moved to call Mr. Goodrich's analysis of the effect of the Priest-O'Hara Bills (8271 and 8275) a most distorted interpretation. Questioning brought out that the FDA officials, great as they believe the need is for new legislation, would rather forego new legislation than to have a new law providing procedure for declaratory judgment or trial de novo in the District Courts in lieu of the present administrative process. In both cases, there would be an appeal to the Circuit Courts of Appeal. It may be recalled that it was only through and after incorporation of the "declaratory judgment" provision that widest endorsement of proposed legislation was obtained by the spokesmen for the broad and diverse industries affected.

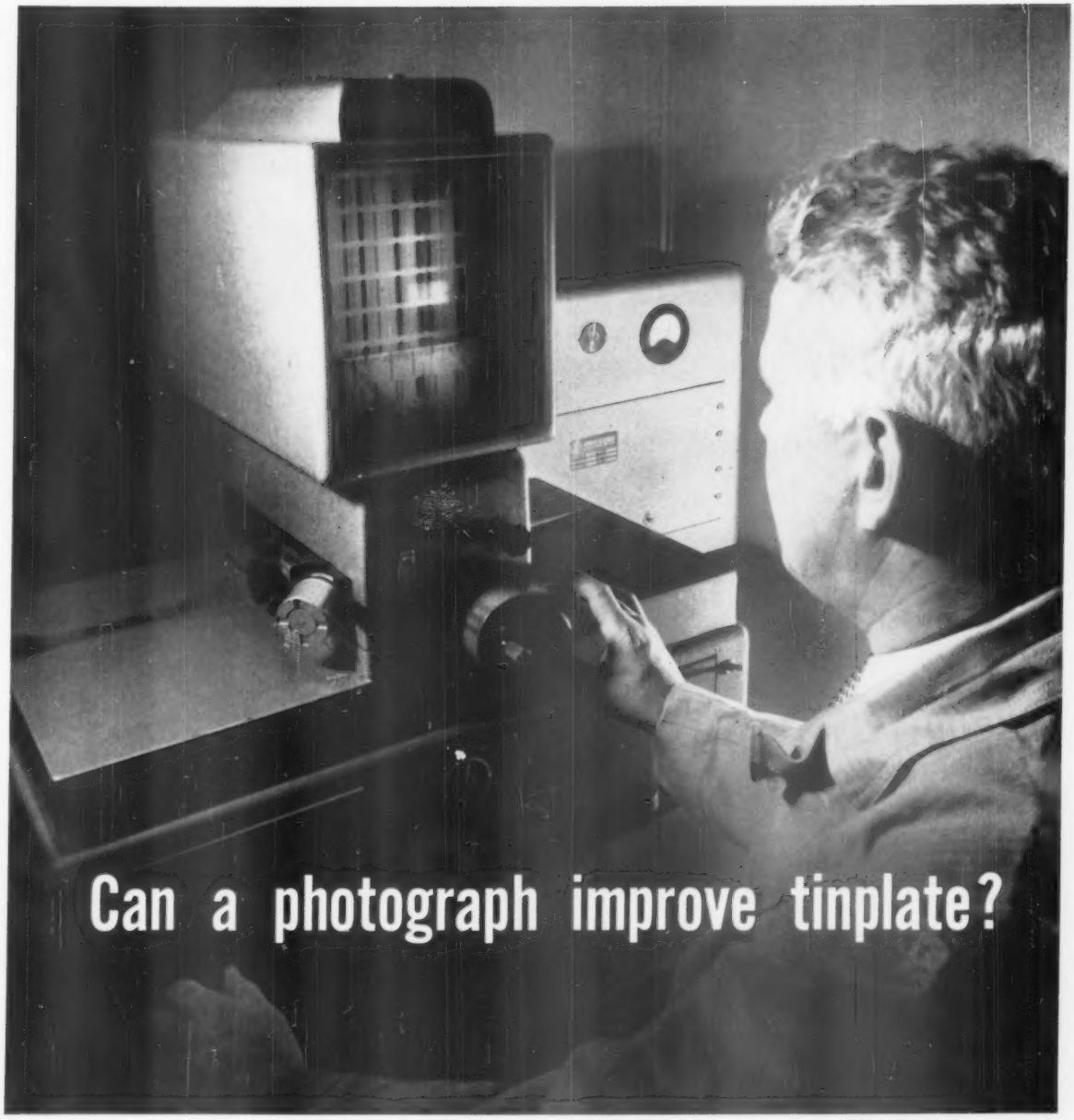
Thus it was on the major procedural issue of the declaratory judgment that the Hearing adjourned on February 14th with strong differences of opinion still evident.

Food and chemical industries' representatives felt so strongly on the procedural phase and on some other aspects that they submitted supplemental statements to the committee, during February and March. These, too, are a part of the public record.

Based on the testimony, a majority of the industries favor omission of the scientific advisory ad hoc committee. However, it is also pertinent to the readers of this journal that one well known food scientist with broad experience on techno-legal matters and procedures sent a letter to the Chairman of the Committee advocating, and giving reasons for, an ad hoc scientific advisory committee such as in the Miller Bill HR 8748 on this subject and as it is also in the Miller Pesticide Law 518.

At the end of the first week of April there was no evidence that a revision and reconciliation of all views on the food additives subject can be readily accomplished. It is possible the Committee Chairman may refer the entire matter back to the interested parties with a suggestion they try to work out some compromise before the next session of Congress. In any event, it is unlikely that a compromise Bill will get through the Committee, the House and the Senate during the remainder of this 84th Congress.

FRANK L. GUNDERSON
Technical Consultant
Washington, D. C.



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BOOKS . . .

ECONOMIC GEOGRAPHY OF INDUSTRIAL MATERIALS. Edited by Albert S. Carlson. Reinhold Publishing Corporation. New York, New York.

A considerable amount of material of interest to food technologists is covered in this useful book. Although only one of the five parts is directly addressed to the economic geography of food, the interdependency of modern industries makes this book a greater resource of data for food industry people than might be assumed. Part I, which is devoted to "populations and their resources" and "transportation," furnishes the economic, technological, and geographic background that explains the distribution of North American populations, chiefly, that of the U. S. A. The influence of technology on transportation is also presented. Part II contains an adequate treatment of the major sources of industrial fuel and power—coal, petroleum, and electric power. The short essay on atomic power which supplements the chapter on electric power outlines, perhaps too meagerly, the present status and future possibilities of atomic power development. Part III, entitled "Products from Minerals," describes the effect on the economy of steel, copper, aluminum, nickel, titanium, phosphate rock, sulfuric acid, lead, and glass—each a chapter in itself and written by a specialist. In general the approach is the growth of the particular industry, source of the ore, production procedures, economics of production, transportation, labor supply, and the role of research. "Natural and Synthetic Products" are discussed in Part IV, with forest products, textile raw materials, organic chemicals, and cotton seed as chapter topics.

Part V treats of agricultural and food products, the coverage being limited to the "dairy industry" and "food and agriculture," the latter chapter being contributed by Dr. F. C. Blanck, editor of the recently published *Handbook of Food and Agriculture*. The economic geography of the dairy industry is well told—and it might be mentioned that the chapter illuminates a number of topics over and beyond the economic geography of the dairy industry. Perhaps no branch of the food industry could exhibit so many changing patterns. Over recent years, new production methods, intensification of sanitation measures, diversification of products, competition from non-dairy sources, and changes in consumer habits have stimulated, and at times bedeviled, the industry. Dr. Blanck's chapter on agriculture and food gives structure to a vast subject matter—no small trick in itself—and in addition is generously supplied with tables and charts that recapitulate the essential facts in an everchanging food economy. A neat compendium of factors that influence the location of a food plant is included.

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FEATURING THIS MONTH . . .

Educating Food Technologists[a]

J. B. S. Braverman, D.Sc.

Professor of Food Technology
Technion-Israel
Institute of Technology, Haifa

MANY INSTRUCTIVE ARTICLES[b] have been written on the general curricula of food technology divisions. In all of them there is more or less the same trend of thought; namely, a laudable desire to integrate the minimum requirements in the various biological disciplines with the fundamental engineering subjects.[c]

None of these articles, however, dealt in detail with the syllabus of the main subject involved; namely the subject of food technology proper. This is a challenging field of educational inquiry and it is the intention of the writer to present here a short outline of such a course as given at the Technion-Israel Institute of Technology in Haifa, Israel.

The Division of Food Technology at this Institute is only two years old. While using with advantage the experience of many important similar institutions in the U. S. and elsewhere, we have tried in certain respects to open somewhat new avenues of educational philosophy and practice, as shown below. It is our belief that the syllabus and its actual application may be of interest to other teachers elsewhere. On the other hand, we expect to be able to profit from any constructive criticism which, we hope, this article will evoke.

General curriculum of the division. Before describing the syllabus of our course in Food Technology, here are a few words regarding the curriculum adopted. The Division in question is part of the Faculty of Chemical Technology. The duration of study is four years of which the first two are taken by all students of the Faculty, the last two years being spent in the Division of Food Technology. The specific subjects taught in the last two years are:

Third Year	*Fourth Year*
Physical Chemistry	Physical Chemistry
Organic Chemistry	Quality Control and Food Evaluation
General Biology	Sanitation
Biochemistry	Nutrition
General Microbiology	Industrial Microbiology
Chemical Engineering	Chemical Engineering
Food Technology	Food Technology
	Instrumentation
	Chemical Engineering Economics
	Undergraduate Research

[a] Contributed by Dr. Braverman on March 7, 1956.

[b] Some six years ago FOOD TECHNOLOGY published a series of such articles. The intention was to elucidate the basic ideas that govern the curricula of American institutions in the field of Food Technology *(3, 4, 5, 6, 7)*. This series was preceded by two articles written by the veteran educator, Dr. W. V. Cruess of the University of California *(1, 2)*. Recently, Dr. Mounfield, the principal of the National College of Food Technology in London, wrote on the same subject in 1952 *(9)*.

[c] The most recent treatment of this topic is Dr. Proctor's excellent article in FOOD TECHNOLOGY for March.

The food technology syllabus. At the very outset we were faced with the problem of how to teach the subject of Food Technology. There were obviously two possible ways: one—to give a descriptive course of the main food industries (milk products, milling and baking, canned fruits and vegetables, meat and fish products, etc., etc.), second—to design the course as a sequence of unit operations common to all food industries. The first path calls for subsequent specialization in the various industries, since otherwise the descriptive course remains very superficial. Such additional specialization necessitates a substantial increase of a well trained staff quite out of proportion to the small group of students which might be expected in a small country such as ours.

We have, therefore, chosen the second path: namely, preparing a student for a rather unknown fate, giving him the principles of food-engineering and expecting him to supplement his general knowledge of food industries by reading selected chapters in the existing textbooks of food technology.

The following is a compiled list of Unit Operations which can be conveniently used as a syllabus in such a course. The bulk of the operations are divided into nine sections. The order in which the various operations are indicated in the list is more or less arbitrary so that it may well be that for a certain food process an operation listed further down in the list might precede the previously listed one. Nevertheless, we have endeavoured to place most of the unit operations in a logical sequence applicable to most canned products. A somewhat similar list has been found in a recently published work on food engineering *(8)*, but for some reason that list was compiled in an alphabetical order. Here is the list as we have developed it:

1. Moving the Crop
1.1 Harvesting
1.2 Unloading
1.3 Storing
  1.3.1 Ripening
  1.3.2 Cold Storing
  1.3.3 Gas Storage
1.4 Conveying

2. Selecting Operations
2.1 Grading
2.2 Sizing
2.3 Washing
  2.3.1 Soaking
  2.3.2 Rinsing

3. Size Reducing Operations
3.1 Crushing
  3.1.1 Grinding
  3.1.2 Milling (Pulverizing)

(Continued on page 12)

it sets a man to thinking!

"Flavor Improvement, New Products, Product Development—what I would have given for that kind of help when I started this business.

"Come to think of it an outside evaluation of flavor might be a smart move for us. Then if our product has become a little old fashioned, we will find it out before decreasing sales tell us.

"Guess we should check with them on Product Development, Eye-Appeal, New Product Suggestions, too. We've known the Stange name for years so—like they suggest—perhaps we'd...better check with Stange and be sure."

The **WM. J. STANGE CO.**, *Manufacturers of Seasonings and Food Colors, extends to the Food Industry a three-fold service involving Flavor and Color Improvement—Product Development—New Product Suggestions. Any or all three services are available through a Stange representative or by letter.*

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Litho in U.S.A.

(Continued from page 10)

3.2 Disintegrating (Pulping)
3.3 Cutting
  3.3.1 Slicing
  3.3.2 Dicing
3.4 Sectioning (See Figure 1)
3.5 Shredding

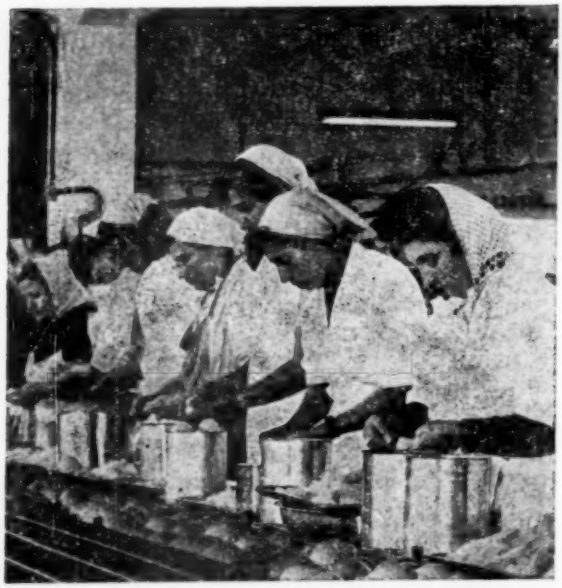

Figure 1. Illustrating a size reducing operation . . . sectioning grapefruit for a compot product manufactured in Israel.

4. Peeling Operations

4.1 Stemming
4.2 Peeling
  4.2.1 Lye peeling
  4.2.2 Flame peeling
  4.2.3 Steam peeling
  4.2.4 Rasping
4.3 Pitting
4.4 Coring
4.5 Trimming
4.6 Husking
4.7 Shelling
4.8 Dressing

5. Chemical and Enzymatic Operations

5.1 Heat Inactivation
  5.1.1 Blanching
  5.1.2 Hot Break
5.2 Deaeration
  5.2.1 Exhausting
  5.2.2 Use of Antioxidants
5.3 Aeration
5.4 Refining
  5.4.1 Bleaching
  5.4.2 Sulfuring
  5.4.3 Immersion
5.5 Hardening
  5.5.1 Hydrogenation
5.6 Aggregation
  5.6.1 Clarification (fining)
  5.6.2 Coagulation (Clotting)
  5.6.3 Curdling
  5.6.4 Churning
5.7 Fortification (Vitamins and Minerals)
5.8 Enzymatic Treatment
  5.8.1 Diastating
  5.8.2 Carbohydrate Elimination
5.9 Ageing
5.10 Deodorization
5.11 Adjusting pH

6. Separating Operations

6.1 Pressing
6.2 Centrifugal Separation
6.3 Screening
6.4 Sifting
6.5 Filtration
  6.5.1 Flotation
  6.5.2 Settling (Sedimentation)
  6.5.3 Fluid-fluid separation (Florentine flask)
6.6 Crystallization
6.7 Extraction
  6.7.1 Diffusion (Leaching)
  6.7.2 Digesting (Maceration)
  6.7.3 Enfleurage
  6.7.4 Percolation
  6.7.5 Selective extraction (counter current)
6.8 Distillation
  6.8.1 Steam Distillation
  6.8.2 Vacuum Distillation
    6.8.2.1 Deoiling
    6.8.2.2 Fractional
    6.8.2.3 Molecular
6.9 Adsorption
  6.9.1 Ion Exchange
  6.9.2 Chromatographic Separation
  6.9.3 Decoloration

7. Addition Operations

7.1 Mixing
  7.1.1 Stirring
  7.1.2 Agitating
  7.1.3 Homogenation
  7.1.4 Emulsification
  7.1.5 Whipping
7.2 Blending
7.3 Kneading
7.4 Coating
  7.4.1 Dipping
  7.4.2 Glazing
  7.4.3 Icing
7.5 Dissolving
  7.5.1 Syruping
  7.5.2 Brining
7.6 Flavouring and Aromatization
  7.6.1 Flavour enhancing
7.7 Colouring

8. Processing Operations

8.1 Chemical Preservation
8.2 Heat Preservation
  8.2.1 Pasteurization
  8.2.2 Sterilization
    8.2.2.1 End over end sterilization
  8.2.3 H.T.S.T.
    8.2.3.1 Steam injection
  8.2.4 Cooking
8.3 Concentration (Evaporation)
  8.3.1 Vacuum Concentration (See Figure 2)
8.4 Baking

(Continued on page 14)

THE Sealva STORY OF "Sealed-In" Flavors

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Where can SEALVA Flavors be used to advantage?

SEALVA Flavors are ideal in any relatively dry, powdered, grained, or flaked mixture to insure inert flavor retention in such products as cake mixes, gelatin desserts, cereals, drink powders, pudding mixes, dairy mixes, ice cream mixes, candies (pressed wafer), pharmaceuticals, proprietaries, oil emulsions, etc.

For better flavor we ask you to investigate SEALVA Flavors before you make your final decision on this most important ingredient.

We are prepared to give you suggestions as to the methods of readily evaluating "sealed-in" flavors for your particular product and also will be happy to assist with technical recommendations for the application of SEALVA Flavors to improve your product. Literature and adequate samples are available.

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(Continued from page 12)

8.5 Drying (Dehydration)
- 8.5.1 Natural Drying
  - 8.5.1.1. Sun drying
  - 8.5.1.2 Air drying
- 8.5.2 Controlling drying
  - 8.5.2.1 Cabinet drying
  - 8.5.2.2 Tunnel drying
  - 8.5.2.3 Drum drying
  - 8.5.2.4 Rotary drying
  - 8.5.3.5 Spray drying
- 8.5.3 Vacuum drying
- 8.5.4 Infra-red drying
- 8.5.5 Lyophilic drying

8.6 Preservation by cold
- 8.6.1 Quick freezing
- 8.6.2 Concentration by freezing

8.7 Fermentation
- 8.7.1 Surface fermentation
- 8.7.2 Submerged fermentation

8.8 Salting

8.9 Smoking

8.10 Irradiation

8.11 Various other methods: (Oligodynamic, Ultrasonics, E. K. filtration)

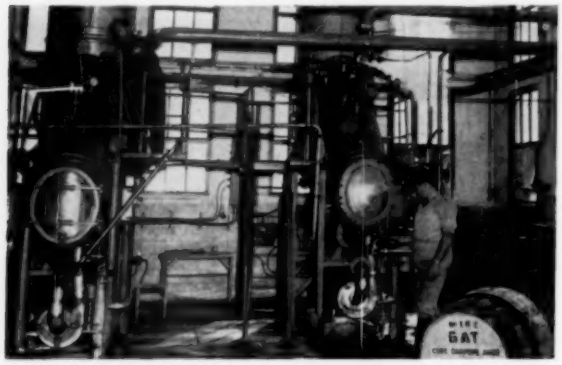

Figure 2. Concentration . . . vacuum evaporation used in a fruit-juice plant in Israel.

9. *Finishing Operations*

9.1 Shaping
- 9.1.1 Forming
- 9.1.2 Casting (Molding)
- 9.1.3 Extruding
- 9.1.4 Flaking
- 9.1.5 Puffing

9.2 Filling
- 9.2.1 Aseptic filling
- 9.2.2 Barreling

9.3 Sealing (Seaming)
- 9.3.1 Vacuum closing
- 9.3.2 Steam injection closing

9.4 Cooling

9.5 Testing

9.6 Marking (Coding)

9.7 Labeling

9.8 Packaging

9.9 Boxing

A number of unit operations as used in food processing have been probably overlooked, and the writer will be extremely indebted for any remarks concerning such omissions.

It has been found convenient to start this course with Section 8 on Processing Operations which are dealt with in considerable detail and which take normally a full semester. The second half year is spent on the remaining sections embodying the problems of moving the crop, selecting, size reducing, peeling, separating and final finishing operations. It should be emphasized that by no means every item mentioned can be treated in sufficient detail and it must be left to the discretion of the teacher and his specific circumstances to decide which of the Unit Operations should be discussed at greater or lesser length.

Towards the end of the year, when the student is already familiar with the principles of biochemistry on the one hand and on the other has acquired some experience during the laboratory exercises, a review of the Chemical and Enzymatic Operations as given in Section 5 of the above list is quite important.

Laboratory exercises. This course is supplemented by a number of bench-scale experiments. An example of one year's laboratory work is given herewith:

(1) Pasteurization and sterilization of milk; centrifugation of cream and churning of butter; curdling of fermented milk products.

(2) Canning of grapefruit segments (lye peeling, syruping, exhausting, sterilization)

(3) Fried potato chips (enzymatic and non-enzymatic browning, use of antioxidants, preservation by drying)

(4) Tomato products (inactivation of pectolytic enzymes, concentration in vacuo)

(5) Jams and Marmalades (formation and testing of gels; pectin grade evaluation)

(6) Essential Oils of Peppermint, Eucalyptus and Lemon (extraction, separation and distillation)

(7) Preparation of pectin from lemon albedo.

(8) Preparation of calcium citrate and citric acid from lemon juice (disintegration, pressing, clarification, precipitation, concentration, crystallization).

Lacking full pilot-plant equipment most of these exercises are carried out on a bench scale so that every student is able to prepare a couple of tins or bottles of the product in question.

Visits to industries. In addition to the laboratory exercises the students visit various food plants and after spending several hours there are called to submit a written report including a flow-sheet and short descriptions of the items of equipment.

The examination at the end of the 3rd-year course. Although, as mentioned, the course is designed to describe Unit Operations—merely with examples of how these are used in various industries—the final examination is the reverse of this procedure. At this examination, lasting 4 hours, each student is given a package of some food product and is called upon to present in writing and by drawings a short project on its manufacture; he must prepare a flow sheet, stating which steps he would select in its processing and why, what equipment he would suggest, and the reason for that selection. This final examination is given in a room housing also the Divisional Library, and the

(Continued on page 16)

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(Continued from page 14)

student is free to use any book or journal available but always giving the reference. In other words the student is called on, in fact, to exercise the facilities and resources that he would be expected to have by a future employer—and he would be free in such a situation to

Figure 3. For his finals . . . the student is handed a package of some Israeli food product and asked to project its manufacture from readying of the raw product on through to filling, packaging and crating.

make use of auxiliary references. Our own object, however, is to learn to what extent the student has developed a capacity to use these references and skill in where to look for them.

The short experience we have had at the Division since the academic year 1953/54 showed that notwithstanding the fact that the student did not have a descriptive course on food industries he found himself able to structure a general system of operations that makes up a given manufacturing process.

The fourth-year students. So far we have described the Food Technology course for the 3rd-year students (Juniors). The Seniors in their last year also receive a course of Food Technology—comprising only selected chapters on various somewhat more complicated subjects of both a scientific and an engineering nature, such as:

Enzymatic and non-enzymatic browning,
Rheology as applied to food,
Application of cold to food preservation
Pumps used in food industry,
Thermobacteriology, etc., etc.

Undergraduate research. Instead of group exercises, every senior is given a small problem for undergraduate research which he has to tackle and work upon for 8 to 10 hour each week. The thesis at the end of the year is expected to include the results of his experimental work, a comprehensive review on some subject relating to his problem, such as, methods of analysis or measuring instruments employed (if any are involved), previous literature, and finally a suggested project if the problem in question has technological significance.

The final examination. The final examination in the fourth year on the subject of Food Technology is a discussion of the student's thesis before a small collegium of two or three members of the staff. The collegium tries to determine the student's general aptitude, his approach to the solution of a given problem and his appreciation of the fact that many different subjects constitute the complicated science which we call "food technology."

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In Memoriam

Paul J. Kolachov, biochemist and research executive, died February 29, 1956, in Bogota, Colombia, where he had been director of the department of technological investigations, a joint enterprise of a Colombian group and the Armour Research Foundation. Born in Russia, he was educated at Prague, noted Czechoslovakian university, and came to the United States in the late 1920's. He began his career at Columbia University as a chemistry instructor, going from there to Lincoln, Nebraska, where, as a chemist for the Roberts Dairy Company, he spent his first years in the industrial field. From Lincoln he moved to Peoria, Illinois, and the Hiram Walker and Sons research department. In 1936 he accepted an important post with Seagram and Sons, Louisville, Kentucky, where he spent the next 15 years. During World War II, Kolachov contributed counsel to the U. S. Department of Agriculture in their search for new sources for rubber (then a critical supply problem) and actively followed through the effort to use a European variant of the dandelion for this purpose.

During the period just prior to his death, Kolachov worked with the Armour Foundation in Chicago to set up the Colombia utilization research agency for studying the applications of chemistry to Colombian agricultural resources. His great progress in organizing and programming this work in Bogota was interrupted by his death on February 29. Paul J. Kolachov is survived by his widow, and one son, Sergei, a student at Yale University.

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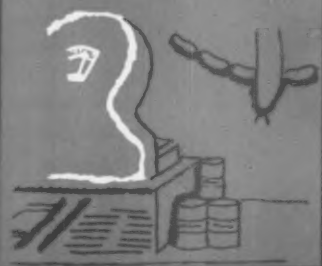

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ANNUAL MEETING ANNOUNCEMENTS . . .

KIMBALL TO GIVE MANAGEMENT VIEW OF INDUSTRIAL RESEARCH

Speakers for the General Session, Monday morning, June 11, at St. Louis will be two noted Midwesterners—Dr. C. N. Kimball of the Midwest Research Institute and Representative A. L. Miller of the Fourth District, Nebraska. Dr. Kimball will discuss a topic close to the interests of food technologists, "How Management Looks at Industrial Research."

Dr. Charles N. Kimball, President of Midwest Research Institute since 1950, has a notable record of achievement as a practicing engineer, an administrator of scientific research programs, and as a business executive. His point of view is an experienced one and he has been privileged to see all sides of the most powerful influence on life today—research. Receiving his Doctor of Science degree at Harvard University in 1934, he was associated thereafter until 1941 with the Radio Corporation of America in electronic research and development. He served concurrently on the Graduate School Staff of New York University.

During the war, Kimball was Vice President and a member of the Board of Aircraft Accessories Corporation, where he directed engineering research programs on radar and its countermeasures under the sponsorship of the U. S. Army Air Forces and the Radio Research Laboratory at Harvard. A pioneer inthe field of radio communications for railroads, he has served as a consultant to the Association of American Railroads. As Vice President of C. J. Patterson Company in Kansas City, he brought the application of industrial electronics to the baking, milling, and food fields. Subsequently, as Technical Director of the Research Laboratories of Bendix Aviation Corporation in Detroit, he supervised programs in guided missiles studies, high altitude meteorological measurements, and nuclear instrumentation, among others.

Dr. Kimball's versatile technical interests may be seen in the fact that he is a Fellow of the Institute of Radio Engineers, a member of the American Association of Cereal Chemists, the Institute of Aeronautical Sciences, and Tau Beta Pi. He is a participant in the National Council of Consultants of the Small Business Administration, a member of the Board of Governors of the Scientific Research Society of America, and is on the Board of Directors of the Young Presidents' Organization.

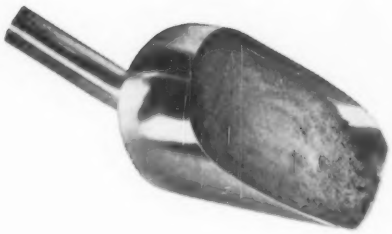
CHEMICALS IN FOODS LEGISLATION TO BE ANALYZED BY NEBRASKA CONGRESSMAN, DR. A. L. MILLER

The history of chemicals in food legislation is replete with lively debate on such issues as standards of safety and levels of tolerance, procedures for establishing same, definitions of the term *additive*, the effect of legislation on research, and the respective roles of Government and Industry in protecting the public. The author of the Miller amendment, which is conceded to be a great improvement over former procedures, will address the IFT membership on June 11.

Dr. Arthur Lewis Miller, Republican, of Kimball, Nebr., born on a farm in Pierce County, Nebr., May 24, 1892, was graduated from the Plainview (Nebr.) High School in 1911 and from the Loyola Medical College, Chicago, Ill., in 1918. He taught in a rural school at Plainview, Nebr., for 2 years. Discharged from the Medical Reserve Corps in January 1919, he has practiced medicine and surgery in Kimball County, Nebr., since August 1919; Dr. Miller was a member of the Nebraska Unicameral Legislature, 1937-41, Stategovernor of Lions Clubs in 1931, president of the State Medical Association in 1939, and a fellow of the American College of Surgeons. He was elected to the Seventy-eighth Congress on November 3, 1942, and relected to the Seventy-ninth, Eightieth, Eighty-first, Eighty-second, Eighty-third, and Eighty-fourth Congresses.

MEMBERSHIP CERTIFICATES AVAILABLE

Engrossed membership certificates will be furnished without cost to members of the Institute who were elected to membership prior to August 1, 1955. The Council of the Institute has authorized the issuance of these certificates to all members in good standing who desire them. Members elected after August 1, 1955, have been receiving them. If you are eligible for a certificate, write to the Executive Secretary, 176 West Adams Street, Chicago, Illinois.



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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

A new spot test for formaldehyde.

West, P. W., and Sen, B. (Coates Chem. Labs., La. State Univ., Baton Rouge). *Anal. Chem., 27,* 1460-1 (1955).

A new method for detecting HCHO by means of a spot test on reagent paper has been developed. The reagent papers are prepd. by impregnating filter paper in an equil. mixt. of K tetracyanonickelate and dimethylglyoxime. As little as 0.5γ of HCHO can be detected. The test can be used as a semiquantitative method and is essentially free from interference.

Determination of water by nuclear magnetic resonance in hygroscopic materials containing soluble solids.

Palmer, K. J., and Elsken, R. H. (Western Util. Res. Branch, Albany 10, Calif.). *J. Agr. Food Chem., 4,* 165-7 (1956).

Investigation of the influence of sol. solids in detns. of moisture in food products by use of nuclear magnetic resonance shows that the H nuclei of solutes absorb in a manner indistinguishable from the H nuclei of H_2O in the high moisture region under conditions of operation of the low-resolution spectrometer described by Shaw and Elsken. Data on several sugar solns., milk samples, and apple juice concentrate illustrate the effect.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The amino acid content of the proteins of barley grains.

Folkes, B. F., and Yemm, E. W. (Dept. Botany, Univ. Bristol, Engl.). *Biochem. J., 62,* 4-11 (1956).

The 4 chief protein fractions of barley grains were isolated; albumin, globulin, prolamin (hordein) and glutelin (hordenin). The amino acid content of these fractions was detd. by microbiol. assay. It was observed that the albumin and globulin closely resemble the protoplasmic proteins in their amino acid content, while hordein and hordenin differ widely from it.

The enzymic synthesis and degradation of starch. Part XX. The disproportionating enzyme (D-enzyme) of the potato.

Peat, S., Whelan, W. J., and Rees, W. R. (Univ. Coll. N. Wales, Bangor). *J. Chem. Soc.,* 44-53 (1956).

It is shown that D-enzyme is different from phosphorylase, R-enzyme and the amylases. It has not yet been possible to sep. D-enzyme from Q-enzyme but it is demonstrated that the branching and the disproportionating activity are due to independent enzymes. Evidence is presented which shows that D-enzyme is a transglycosylase, transferring two or more glucose units from a maltodextrin substrate to a suitable acceptor and that, in the transfer, only α-1:4-glucosidic links are synthesized. The natural substrates for D-enzyme appear to be the maltodextrins, from maltotriose upwards; neither glucose nor, in all probability maltose functions as donor substrate. The enzyme is not so selective with respect to the "accepting" mol. The enzyme system of the potato was capable of disproportionating short-chain linear dextrins into products of lower and higher mol. wt.

Chemistry and physiology of phospholipids.

Berry, J. F. (Biochem. Div. Chem. Inst., Ontario, Canada). *Nature, 177,* 21-3 (1956).

A résumé of the papers presented at this symposium (October 12-13, 1955) is given. The first part of the symposium, entitled "Chemistry of Phospholipids," dealt with advances in knowledge of the structure and properties of these substances, including synthesis of glycerolphosphatides (E. Baer); the chemistry of phosphoinositides (J. Folch) and sphingolipids (H. E. Carter). The second part of the symposium, entitled "Metabolism and Function of Phospholipids," dealt with the biological synthesis of phospholipids (E. P. Kennedy); the *in vitro* metabolism of phospholipids (L. E. Hokin) and the current views on the function of phospholipids (J. M. R. Beveridge). The papers and discussions will be published in Can. J. Biochem. and Physiol.

Detoxication of tung meal.

Lee, J. G. (Dept. Agr. and Biol. Chem., La. State Univ., Baton Rouge). *J. Agr. Food Chem., 4,* 67-8 (1956).

Meals nontoxic to chicks and rats were produced by EtOH extn. followed by steaming. The quality of tung protein for the rat is low, with lysine being the limiting amino acid. Thus, tung meal does not offer much promise as an economical source of protein for cereal supplementation.

Infra-red absorption spectra and protein-sugar interactions.

Goulden, J. D. S. (Natl. Inst. for Research in Dairying, Univ. Reading, Engl.). *Nature, 177,* 85-6 (1956).

Protein-sugar interaction and its effect upon infra-red spectra is demonstrated by the spectra of 2 different mixts. of casein and lactose. It is postulated that the interaction of casein with sugars forms the first stage in the series of reactions involved in the browning of milk and that the carbohydrate and protein mols. are held together by an H-bonding mechanism.

Rate of glycogenesis in the liver of the rat after parenteral administration of glucose, fructose and invert sugar.

Longley, R. W., Shirkey, A. L., Alvig, O. H., and Roe, J. H. (Dept. Biochem., Sch. Med., George Washington Univ., Washington, D. C.) *Proc. Soc. Exptl. Biol. Med., 90,* 510-11 (1955).

Rate of glycogenesis in the liver of the rat after intraperitoneal injection of sugar soln. was found to be highest after fructose, lowest after glucose, and intermediate between fructose and glucose after invert sugar. During the first 3 hrs. after injection the rate of glycogen formation was approx. twice as fast after fructose as after glucose, a finding that explains, in part, the more rapid disappearance from the blood of fructose than glucose after parenteral administration.

Carotenoids.

Frank, S. *Sci. American, 194,* 80-6, January 1956.

The possible role of the carotenoids in plants and animals is discussed. Particular emphasis is given to the possible relationship between the carotenoid mol. and the synthesis of chlorophyll.

MICROBIOLOGY

Combined effects of heat and radiation in food sterilization.

Kempe, L. L. (Dept. Bacteriol., Univ. Mich., Ann Arbor). *Appl. Microbiol., 3,* 346-52 (1955).

Preirradiation with gamma rays from cobalt-60 sensitized the spores of *Clostridium botulinum* to the subsequent lethal action of heat, but preliminary heat shocking at 99° C. did not affect the lethal action of subsequent gamma irradiation. Increased amts. of gamma radiation caused increased degrees of sensitization to the subsequent lethal action of heat. This was evidenced by the increasing steepness of the thermal-death time curves developed with those spores that received increasingly higher dosage of gamma radiation. The F_0 value of *Clostridium botulinum* spores could be reduced approx. four-fold by preirradiation. The amt. of this effect was found to be less in gelatin and nutrient broth than in phosphate buffer.

NUTRITION

The origin of fecal fat. I. Experiments with rats on a fat-free diet.

Hosalek, A. (Univ. Graz. Germany. *Hoppe-Seylers Z. physiol. Chem., 298* (1/2): 55-64 (1954); *Biol. Abstr., 29,* 25629 (1955).

The higher fatty acids present in the feces of rats on a fat-free diet was estd. following extn. and pptn. with urea. When the cellulose content of the diet is increased so that the fecal dry wt. increases 4-fold, the fatty acid content is ½. This is attributed to the increased rate of feces elimination and consequent decreased development of bacterial intestinal flora. In confirmation of the theory that the

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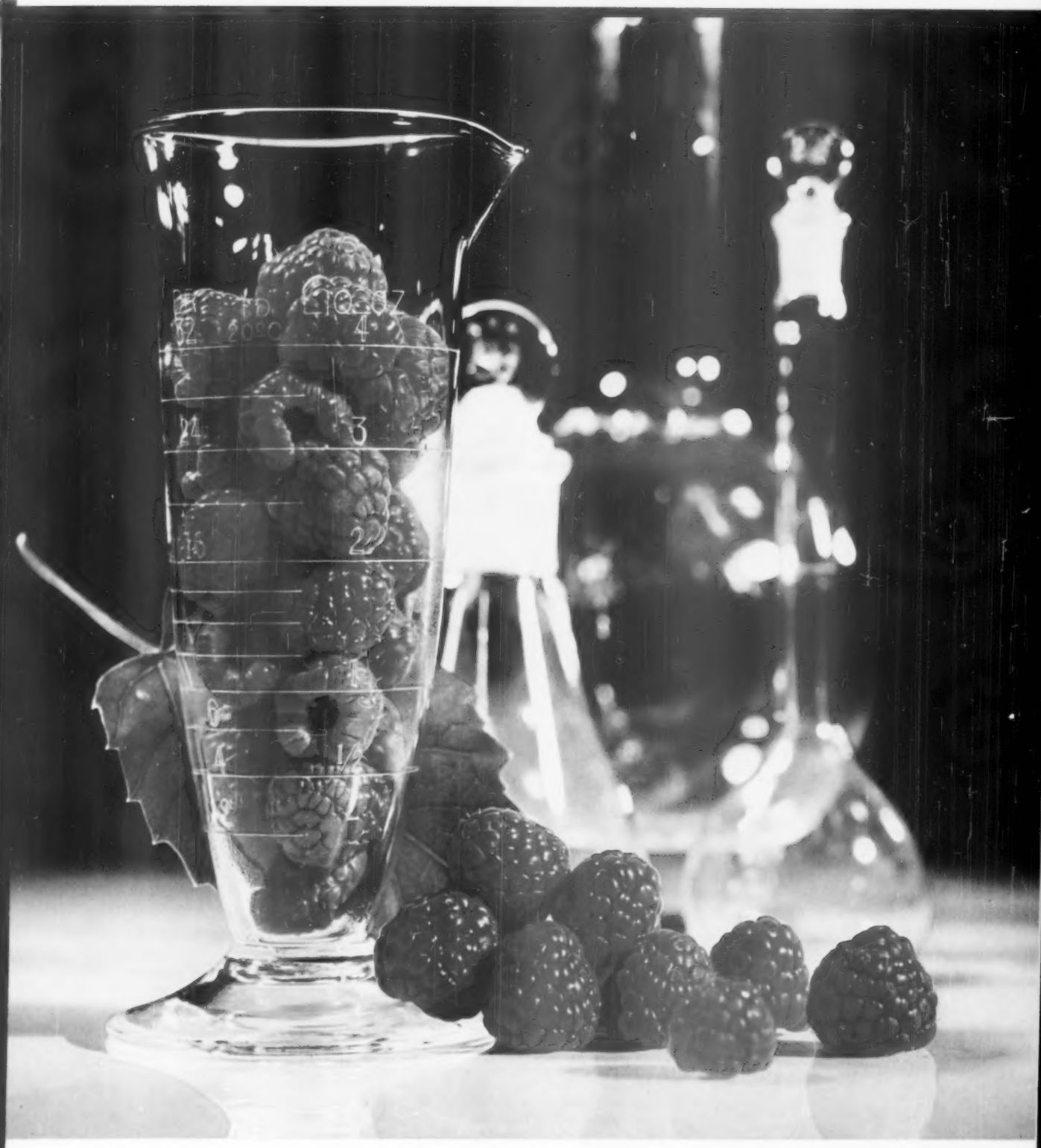

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(Continued from page 20)

origin of the fatty acids is bacterial it is demonstrated that a diet with a high cellulose content and supplemented with Terramycin leads to elimination of feces practically free of higher fatty acids.

Comparative effects of dietary sucrose and cornstarch on tryptophan requirement of the rat.

BAVETTA, L. A., AND ERSHOFF, B. H. (Dept. Biochem., Univ. Southern Calif., Los Angeles). *Proc. Soc. Exptl. Biol. Med., 90,* 349-51 (1955).

Immature female rats were fed tryptophan-free rations supplemented with graded levels of *dl*-tryptophan and contg. either sucrose or cornstarch as the source of dietary carbohydrate. Rats fed *dl*-tryptophan at a level of 600 mg./kg. of diet grew poorly when sucrose was the dietary carbohydrate but showed a significant increment in body wt. over that observed on the sucrose-contg. diet when cornstarch replaced sucrose as the source of dietary carbohydrate. At higher levels of tryptophan supplementation (1.8 g. or 5.4 g. *dl*-tryptophan/kg. of diet) no significant difference in wt. increment occurred between rats fed cornstarch or sucrose contg. rations.

Metabolism of the essential fatty acids. II. The metabolism of stearate, oleate, and linoleate by fat-deficient and normal mice.

MEAD, J. F., SLATON, W. H., AND DECKER, A. B. (Atomic Energy Project, Med. Sch., Univ. Calif., Los Angeles). *J. Biol. Chem., 218,* 401-7 (1956).

Normal and fat-deficient mice were given orally carboxy-labeled Me stearate, oleate, or linoleate. The C^{14} content of the respiratory CO_2 and various body lipides were detd. Fat-deficient mice metabolized stearate and linoleate at a significantly greater rate than did normal mice and oleate at a lower rate. The incorporation of C^{14} into cholesterol seemed to bear an inverse relationship to that in total respiratory CO_2. No evidence could be found for the conversion of oleate to linoleate *in vivo*, but linoleate may be converted to arachidonate.

Interrelationships of methionine and vitamin B_6 in human subjects.

MARQUEZ, L. R., CHESLOCK, K. E., AND REYNOLDS, M. S. (Dept. Foods and Nutr., Univ. Wis., Madison). *Proc. Soc. Exptl. Biol. Med., 90,* 352-5 (1955).

A study of the interrelationship of methionine and pyridoxine was made in adult human subjects maintained on a semi-synthetic diet, low in vitamin B_6. No effect of a high dosage of methionine on the urinary excretion of B_6 and its metabolites was observed in the study. The role of vitamin B_6 in the methylation of nicotinamide is shown by the increased urinary excretion of N-methylnicotinamide by human subjects, when given methionine plus pyridoxine but not when given only methionine.

Nutrition of aged cardiac patients.

MONAT, H. A. (Georgetown Univ. Hosp., Washington). *Geriatrics, 10,* 581-2 (1955).

A new nutritional concept for aged cardiacs based on a submaintenance diet low in calories but high in nutritional requirements and vitamins, with resulting improvement in general well-being of the elderly patient. Thus by increasing effectiveness of cardiac medication, demand for such medication is diminished.

PHARMACOLOGY AND TOXICOLOGY

Chemical model of drug action.

GERO, A., AND REESE, V. J. (Div. Pharmacol., Hahnemann Med. Coll., Phila., Pa.). *Science 123,* 100 (1956).

A hypothesis for the mechanism of drug action is presented. It is based on the observation that a striking number of drugs that display a great variety of effects contain certain functional groups at the same distance of about 5½ Å from each other as the distance between 2 turns of the α-protein helix. The fact that these functional groups (hydroxyl and amine) are capable of H-bonding suggests that the mols. of such drugs might be able to attach themselves by H-bonds to proteins, thus changing the native H-bonding arrangement and the shape of the protein mols. If the protein is an enzyme, and if the change is great enough and occurs at a sufficiently critical pt. of the enzyme mol., an alteration of its specificity may result. Drug action could be the consequence of such alteration in an enzyme.

PHYSIOLOGY AND MEDICINE

The metabolism of ethyl alcohol in the rat.

OWENS, A. H., AND MARSHALL, E. K. (Dept. Pharmacol., The Johns Hopkins Univ., Baltimore, Md.). *J. Pharmacol. Exptl. Therap., 115,* 360-70 (1955).

In the rat, the rate of decline of the concn. of alc. in the blood is constant, implying a constant rate of oxidation independent of the amt. present. The rate of oxidation did not vary with doses of 1 and 2.5 g. per kg. The rate of oxidation was influenced by diet. On a protein-free diet it was decreased to about one-half and with 48 hrs. fasting to about one-third of the normal value. The rate of oxidation was usually increased by injection of Na pyruvate and DPN but similar increases occurred after injections of NaCl. This effect appears to be due to a discharge of the adrenal medulla. When alc. was given by mouth about 30% remained in the gastrointestinal tract at 1 hr. Subsequent absorption appeared to proceed at a const. rate.

Serum cholesterol reduction in patients by the oral administration of a brain extract.

JONES, R. J. (Univ. Chicago, Div. Biol. Sci., Dept. Med.). *J. Lab. Clin. Med., 47,* 261-9 (1956).

Nine subjects with coronary artery disease and varying degrees of hypercholesterolemia were fed a cerebroside fraction of beef brain for periods of 3 to 8 wks. Each of the subjects showed a fall in serum cholesterol during the exptl. period which was paralleled by significant but slightly lesser reduction in phospholipid, neutral fat, and beta lipoprotein. The alpha lipoprotein was not significantly affected.

The fallibility of the glucose tolerance test in the aged.

WAGNER, A. (Northwestern Univ. Med. Sch., Evanston, Ill.). *Geriatrics, 10,* 588-94 (1955).

Annual sugar tolerance tests on a group of aged women revealed no specific correlation between the characteristics of the glucose tolerance curves and the clinical state of the patient. The most reliable index of metabolic defect appears to be persistent elevation of the fasting blood sugar. Three hour level is of secondary importance rather than two hour level. Least reliable index is peak of curve.

ENGINEERING AND PLANT EQUIPMENT

Mixing by agitation of miscible liquids. Part II.

VAN DE VUSSE, J. G. (Kininklijke/Shell-Laboratorium, Amsterdam). *Chem. Eng. Sci., 4,* 209-20 (1955).

In the second article of the series, various recommended equations are presented for power consumption of several types of mixers. Also discussed at length are the factors to be considered for detg. optimum mixing conditions.

Apparatus for automatic determination of gel time.

BILLHEIMER, J. S., AND PARRETTE, R. (Aerojet-General Corp., Azusa, Calif.). *Anal. Chem., 28,* 272-3 (1956).

The app. periodically dispenses a glass bead to the surface of polymerization sample contained in a vial suspended in a const. temp. bath. The dispensed beads sink to the bottom of the vial as long as the sample is fluid. After a gel has formed, subsequent beads are retained on the top surface of the sample. The gel time is thus indicated by the no. of beads in the bottom of the gelled mass, each bead representing one time interval.

FOOD AND FOOD TECHNOLOGY

FATS AND OILS

A simplified method of preparing pure mono-, di- and tri-glycerides.

HARTMAN, L. (Fats Research Lab., Dept. Sci. and Ind. Research, Wellington, New Zealand). *Nature, 176,* 1024 (1955).

Method employs selective esterification in which the addn. of N, N-dimethyl formamide ensures the miscibility of glycerol with other components. Monoglycerides are prepd. using 5-10 mol. of

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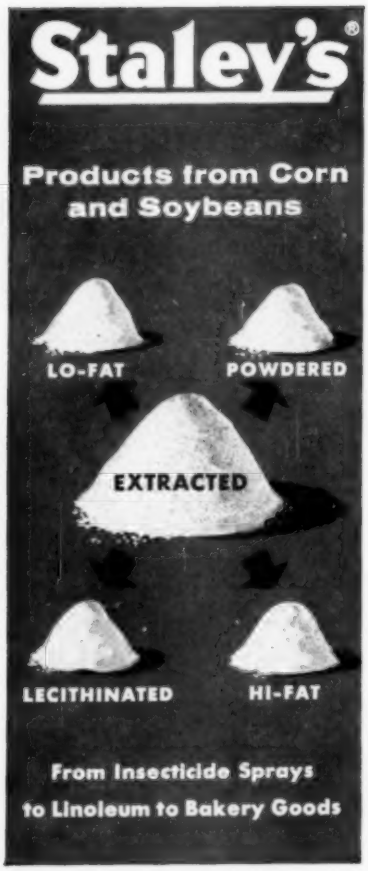

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glycerol per 1 mol. of fatty acid chloride. Monoacid *a,á*-diglycerides are obtained using 1 mol. of glycerol per mol. of fatty acid chloride. Diacid diglycerides are produced in the reaction between a monoglyceride and another fatty acid chloride used in approx. equimolar proportions. By extending this procedure to the prepn. of mixed triglycerides, all 3 isomers of triglyceride contg. stearic, palmitic and oleic acid radicals are obtained in good yields by 3-stage direct esterification.

Urea adducts of glyceryl esters.

AYLWARD, F., AND WOOD, P. D. S. (Dept. Chem. and Food Technol., Borough Polytechnic, London). *Nature, 177,* 146 (1956).

Investigation of the possibility of prepg. pure glycerol mono-esters by stepwise extractive crystn. with urea in MeOH soln. from a mixt. of fatty acids, free glycerol and varying proportions of mono-, di- and tri-glycerides. Selected for study was a com. prepn. of monostearin. The most favorable results were obtained when the wt. ratio of lipid, urea and MeOH was 1:14:80 producing a lipid fraction in soln. of 90% monostearin content (or 83% yield).

FRUITS AND VEGETABLES

U. S. soybeans are food for the Japanese.

STRAYER, G. M. (Am. Soybean Assoc., Hudson, Iowa). *Soybean Digest, 16,* 8-10, January 1956.

Japan imports 26 million bushels of soybeans which are processed in approx. 3,000 oil mills, 6,000 soy sauce plants, 5,000 soybean paste plants, and 50,000 tofu or soybean cured plants. Soybeans and rice are the major dietary items. Wheat products and fish are the other important dietary constituents. In the Japanese diet, soybeans are seldom used in the whole state. They are usually fermented or made into milk and then the curd products utilized.

Marketing vegetable proteins.

OLENDORF, H. A. (Spencer Kellogg & Sons, Inc., Buffalo, N. Y.). *Soybean Digest, 16,* 18-20, January 1956.

Several years ago retailing of soy flour in small packages to the housewife was not successful enough to warrant continuation. Processors thereby decided that the proper place to sell soy flour was at the food processor and blender level. Soy flour is currently being used in cereal bread mixes, pancake and waffle mixes, infant foods, doughnuts, cookies, hypoallergenic products and sausage binders and extenders. A considerable vol. of the meal is used in poultry, livestock and pet feeds. Soybeans are also used industrially in the manufacture of glue, paper coatings, paints, fine foam liquids, fiberboards, felt base floor coverings, printing inks, and leather finishers.

Part I — Comparison of carotenoids of Valencia orange peel and pulp. Part II—Carotenoids of aged canned Valencia orange juice.

CURL, A. L., AND BAILEY, G. F. (Western Util. Res. Branch, Albany 10, Calif.). *J. Agr. Food Chem., 4,* 156-62 (1956).

A comparison of the peel and pulp of early-season Valencia oranges showed over 60% of the total carotenoids but less free diols and polyols in the peel. Qualitatively the components were nearly identical; quantitatively peel carotenoids contained much more violaxanthin. Countercurrent distribution studies of the carotenoids of aged canned Valencia orange juice, stored for 3 years at room temp. showed no significant hydrolysis of xanthophyll esters or changes in compn. of nonether carotenoids. The xanthophyll epoxides, about half of the total carotenoids of fresh orange juice, had entirely disappeared; the corresponding isomeric furanoxides were present in greater proportions than in fresh juice.

Influence of maturity and storage treatments upon the ascorbic acid content of the seeds of southern peas.

HOOVER, M. W. (Univ. Fla. Agr. Expt. Sta., Gainesville). *Food Research, 20,* 469-73 (1955).

Peas are high in ascorbic acid if harvested early and used immediately or stored at 40° F. up to 72 hrs. With higher storage temp. or longer storage time ascorbic content decreases. Peas harvested later when the green color begins to leave the pod contain little ascorbic acid.

Effect of degree of enzyme inactivation and storage temperature on quality retention in frozen peas.

DIETRICH, W. C., LINDQUIST, F. E., BOHART, G. S., MORRIS, H. J., AND NUTTING, M. D. (Western Util. Res. Branch, Albany 10, Calif.). *Food Research, 20,* 480-91 (1955).

Peas contg. active catalase showed greater loss of ascorbic acid and degradation of chlorophyll than peas in which catalase and peroxidase were inactivated. Samples blanched just adequately for a semi quant. peroxidase test maintained better color, flavor, and more ascorbic acid than samples blanched either longer or shorter times. Amount of change increased with increased storage temp.

MILK AND MILK PRODUCTS

The relationship of serine deamination and hydrogen sulfide production by Lactobacillus casei to Cheddar cheese flavor.

KRISTOFFERSEN, T., AND NELSON, F. E. (Dairy Ind. Sec., Iowa Agr. Exptl. Sta., Ames). *J. Dairy Sci., 38,* 1319-25 (1955).

Lactobacillus casei types were isolated from several samples of Cheddar cheese. Types capable of producing H_2S in the growth medium were found only in cheese with a flavor score of 39.0 or better. The ability of the isolates to deaminate serine varied, but the strains showing the highest activity were isolated from the better samples of cheese. Some exptl. cheese was examd. for -SH groups and "free" H_2S. Both of these values increased as the cheese matured. At 6 mos. the cheese

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contg. the highest relative concn. of "free" H_2S received the highest Cheddar flavor intensity score.

A quantitative evaluation of changes occurring during heat treatment of skimmilk at temperatures ranging from 170° to 300° F.

HARLAND, H. A., COULTER, S. T., TOWNLEY, V. H., AND JENNESS, R. (Dept. Dairy Husbandry, Univ. Minn., St. Paul). *J. Dairy Sci., 38,* 1199-1207 (1955).

At higher temp. the time required for a given degree of serum protein denaturation is greater than that indicated by extrapolation of a plot based on lower temps. Heat treatments necessary for max. production of free sulfhydryl groups in skimmilk are defined. A specification of 80-85% serum protein denaturation should insure adequate baking quality for skimmilk.

POTATOES

Radiation and resistance of tubers to rot.

WAGGONER, P. E. (Dept. Plant Pathol., Conn. Agr. Exptl. Sta., New Haven). *Am. Potato J., 32,* 448 (1955).

Sprout-inhibiting doses of ionizing radiation do not increase resistance to infection of wounds by bacteria. Only periderm formation was inhibited by radiation. Thus, under certain conditions of inoculum, wounding, and atm., increased rot can occur in irradiated potatoes.

SUGARS AND STARCHES

Quantitative determination of the amino acids of sugar cane juice.

ROBERTS, E. J., AND MARTIN, L. F. (Southern Util. Res. Branch [SRRL], New Orleans, La.). *Sugar, 51,* 32-3 (1956).

Amino acid content of sugar cane juice is detd. by direct application of the juice to a column of ion-exchange resin. Threonine, proline, and phenylalanine have been identified as present in juice; these acids have not been previously reported in juice.

Characterization of starch and related polysaccharides by differential thermal analysis.

MORITA, H. (Chem. Div., Can. Dept. Agr., Ottawa). *Anal. Chem., 28,* 64-7 (1956).

Differential thermal analysis was investigated as a technique for characterizing starches which showed thermal properties dependent upon the method of prepn. Distinct variations were observed among the amylose and amylopectin fractions. A tentative interpretation of the thermograms is given. The analysis has been extended to glycogen, cellulose, and dextran.

TASTE TESTING

Variation in flavor judgments in a group situation.

FOSTER, D., PRATT, C., AND SCHWARTZ, N. (U. S. Testing Co., Inc.). *Food Research, 20,* 539-44 (1955).

(Continued on page 28)

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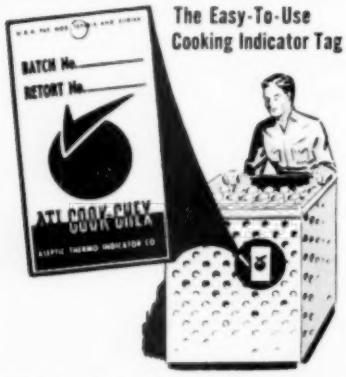

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Responses of observers in a round-table situation were shown to be influenced by the report of the first observer. Qualitative flavor differences and preferences were created where none existed.

ORGANIC CHEMISTRY

The action of ionizing radiations on organic compounds.

COLLINSON, E., AND SWALLOW, A. J. (Sch. Chem., Univ. Leeds, Engl.). *Quart. Rev., 9,* 311-27 (1955).

A summary of what is known about the different types of reactions brought about by ionizing radiations, and the principles which lie behind them. Discussed are the polymerization of satd. and unsatd. hydrocarbons, as well as the behavior of the following to ionizing radiations: -OH, -COOH, $-NH_2$, macromolecules, and aromatic compds. The effect of irradiation upon oxidation, halogenation, and reduction is also outlined. It is predicted that besides their possible use for the sterilization of foods and pharmaceuticals, ionizing radiations may also find application in the chem. industry, particularly in the production of expensive chemicals, and the processes of polymerization, depolymerization, and chlorination.

PHYSICAL RESEARCH

Peptization of lignins.

BUZAGH, A., AND TAR, I. (Inst. für Kolloidchemie and Kolloidtechnologie der Eötvös Loránd Universität Budapest (Ungarn). *Kolloid Z., 144,* 45-58 (1955).

Solubility of lignins goes through a max. as its concn. in the suspension is increased. Peptization of lignins is impaired in proportion to salt concns. and in accordance with lyotropic areas and valence of cations. Equivalent wts., unicellar wts., aggregates, sol. stability and coagulability are discussed.

The diffusion of water vapour in leather.

MITTON, R. G. (Brit. Leather Manufs. Res. Assn., Milton Pk., Egham, Engl.). *J. Soc. Leather Trades' Chemists, 34,* 385-400 (1955).

In studies on both a "steady state" and "non-steady" state rate of diffusion of H_2O vapor through leather it was shown that practically the whole of the transport of moisture takes place through the capillary spaces; at most, the amt. that diffuses through the solid fibers is less than 3% of the total in sole leathers, and less than 1% in light leathers.

POLYMER RESEARCH

Preparation and structure of synthetic hexose polymers.

RICKETTS, C. R., AND ROWE, C. E. (Birmingham Accident Hosp., Bath Row, Birmingham 15, Engl.). *J. Chem. Soc.,* 3809-13 (1955).

Dry HCl passing over glucose monohydrate for 0.5 hr. gave a plastic mass that was permitted to polymerize 5 days to give max. yield of polyglucose. Total nondialyzable material was about 45%. Infrared absorption studies indicate the presence of 1:6 linkages, confirmed by ionophoresis in borate buffer of polyglucose hydrolyzates. Ionophoresis of the polymerization mixt. shows the presence of maltose as well as isomaltose, so that 1:4 linkages also probably occur. Polymers have been prepd. from maltose, lactose and galactose.

Negative thixotrophy of aqueous solutions of polymethacrylic acid.

ELIASSAF, J., SILBERBERG, A., AND KATCHALSKY, A. (Polymer Dept. Weizmann Inst. of Sci., Rehovot, Israel). *Nature, 176,* 1119 (1955).

Aqueous solns. of polymethacrylic acid are believed to exhibit the most pronounced reversible isothermal increase in consistency during mechanical treatment as described in the literature. An explanation for this characteristic is given.

MISCELLANEOUS INFORMATION

X-rays for plants and soil. New analytical method saves time and material.

BRANDT, C. S. (U. S. Plant, Soil, and Nutr. Lab., Ithaca, N. Y.). *Farm Research, 22,* 10-11, January 1956.

The x-ray spectrograph is being used at the U. S. Plant, Soil and Nutrition Lab. at Cornell Univ. for plant and soil analysis. Tests are run and results recorded in about 2 hrs. as compared with a wk. using other methods. The spectrograph detects all 7 nutritional elements except Co and P.

The Sargasso sea.

RYTHER, J. H. *Sci. American, 194,* 98-104, January 1956.

Legends relate that the Sargasso Sea in the Atlantic Ocean is so thick with seaweed that ships cannot penetrate it. However, further investigations have indicated that this body of water is really the biologically poorest ocean H_2O ever studied.

An instrument for measuring soil-moisture deficit.

STANHILL, G., AND WINTER, E. J. (Natl. Vegetable Research Sta., Warwick, Engl.). *Nature, 176,* 1276 (1955).

Describes a combined rain-gauge and evaporimeter which may prove suitable for use by growers for day-to-day control of irrigation and for use in meteorological stations. The instrument is intended to be placed in a growing crop, so that it collects rain and irrigation H_2O in a common receiver; an evaporation surface, consisting of an unglazed ceramic disc, draws its H_2O supply by capillarity from this receiver. When the instrument is correctly adjusted, the amt. of H_2O in the receiver at any time corresponds to the amt. of H_2O remaining in the soil, so indicating directly the current soil-moisture deficit.

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AWARDS AND HONORS . . .

DR. BERNARD E. PROCTOR NAMED 1956 APPERT AWARD MEDALIST

The Chicago Section of IFT has chosen Dr. Bernard E. Proctor as the 1956 Appert Medalist. A true example of outstanding achievement in food technology, Dr. Proctor has spent his entire professional career in teaching, research and administration — his greatest achievement being the improved production of young food technologists of superior quality.

Dr. B. E. Proctor . . . to receive Appert Medal at 16th Annual Meeting of IFT, St. Louis, Missouri, in June

Early years. Bernard E. Proctor was born in Malden, Massachusetts, on May 5, 1901. He received his elementary education in the public schools of that city, then entered the Massachusetts Institute of Technology in 1919, and graduated with the class of 1923. His four years of undergraduate training brought him to know and become inspired by Professor Samuel C. Prescott, a man whose great influence on food research and technology needs no elaboration here for it is known to all.

During this 4-year period Proctor the student became imbued with the appeal of a career in food technology and realized full well the desirability of graduate study in that relatively new field (then called Industrial Biology) at M. I. T. While graduate training was appealing, he faced the very practical problem of self-support, and soon after receiving his S.B. degree accepted a post as Instructor in Biochemistry at the Boston University School of Medicine. Fortunately, while there, he was able to pursue graduate studies at M. I. T.

It was during this period that he married Miriam "Pat" Patten of Andover, Massachusetts.

In 1927 he obtained his Ph.D. degree at M. I. T. and in the fall of that year began his career in Food Technology at his Alma Mater. From an Instructorship in 1927, he rose to become an Assistant Professor in 1930, an Associate Professor in 1936, and a full Professor in 1944.

Events in his career. During these seventeen years, Food Technology flourished at M. I. T. and under Dr. Proctor's guidance it became known as an outstanding center in this field.

The years 1937 and 1939 saw two outstanding Food Technology Conferences at M. I. T. and from these two meetings the Institute of Food Technologists grew and was chartered. Dr. Proctor took an active part in the planning and execution of these conferences and in the formation of the Institute. The minutes of the early council meeting of the IFT reveal the vigorous and devoted part he played in forming and shaping its future course. He founded and was elected the first Chairman of the Northeast Section of the Institute.

As a result of his tremendous efforts in developing Food Technology at M. I. T., the Administration of the Massachusetts Institute of Technology in 1945 recognized the growth and importance of this field and designated Food Technology as a separate department at M. I. T. It was placed on a par with the nineteen other departments and was authorized the right to grant degrees, both graduate and undergraduate. The Samuel Cate Prescott Laboratories of Food Technology were established during this period, and Dr. Proctor was appointed their Director.

Dr. Proctor set up a new curriculum in Food Technology at M. I. T. in 1945 which began to attract students from all over the world—a curriculum of great depth in the basic fundamentals of mathematics, physics, engineering, chemistry, bacteriology, etc., but also designed to prepare young people for all types of jobs in all segments of our vast food industry.

It was Dr. Proctor who inaugurated the Summer Refresher Course in Food Technology at M. I. T. This course was designed for industrial scientists, teachers and researchers. He taught the course single-handed for many years, lecturing six hours per day for three weeks! (Since 1949, this course has been given by the entire departmental faculty of seven professors.)

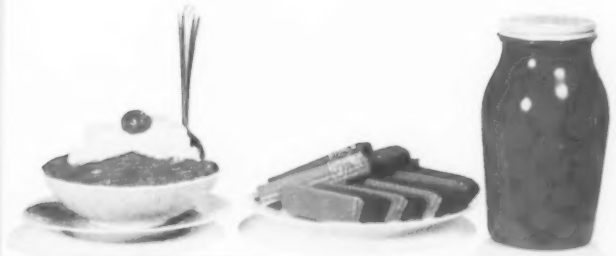
Under Dr. Proctor's leadership as Director of the Prescott Laboratories, research in the Department was greatly intensified and expanded. Pioneering and daring researches in "cold" sterilization began under his leadership in the 1940's—a research program that has been broadened by the Military to a scope requiring a multimillion dollar annual budget!

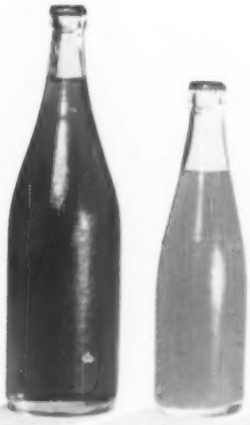
In 1951, Dr. Proctor was made Head of the Department of Food Technology. From a total of 26 personnel when he assumed administration, the Department has grown in size to almost eighty people. Over 240 papers and reports have emanated from research guided and encouraged by him—mostly original work in new and unchartered fields. He has been a steady contributor on his own account to food research. His most recent contributions in original and potentially important research are in the area of evaluation of the rheological properties of foods, using new electronic techniques.

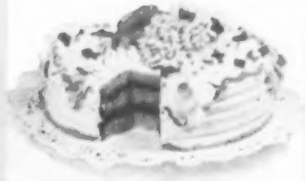
During World War II he was Director of Subsistence and Packaging Research and Development of the Office of the Quartermaster General. Since that time he has served science and the nation as a member

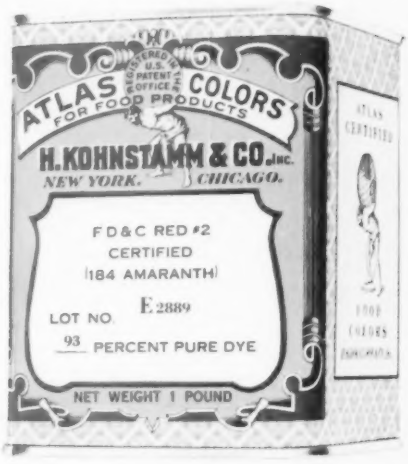
(Continued on page 32)

FOOD NEEDS COLOR









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(Continued from page 30)

or Chairman of a number of National Research Council Committees that act in an advisory capacity to Armed Forces food research and development.

The impact that he made on the exploitation of the potentialities of "the peaceful atom" was recognized in 1955 when he was appointed a member of the official delegation to the United Nations meeting at Geneva.

His professional affiliations and activities are too numerous to mention. To him IFT is probably his most important association. He was made President-Elect of IFT in 1951, serving as President for the ensuing year.

He has also been active in the American Chemical Society and has been Chairman of the Division of Agricultural and Food Chemistry and of the Herman Frasch Foundation Awards Committee since 1947.

Bernie Proctor, by his ceaseless efforts and deep concern, could be designated as Mr. Food Technologist himself, and his countless friends throughout the world will rejoice in his being selected as the Appert Medalist of 1956.

During his more than thirty years of professional activity, Dr. Proctor has been aided by his most charming wife, Pat. She has visited one food plant after another with him and is always present at both local as well as national IFT meetings.

Bernie Proctor's main hobby is fishing, and part of each summer is spent on the Contoocook River where the Proctors have a small camp, the camp where Dr. Proctor spent his summers as a boy. Second only to fishing is his hobby of agriculture, and he prides himself on the tremendous squashes produced in his garden by his own private enterprise.

Hard work, astute and profound thinking and planning distinguish and characterize our 1956 medalist—these plus his wonderful qualities of friendliness. Ahead of Dr. Proctor are many productive years—years which will result in many more young people being so fortunate as to be able to say "he was my teacher." That his research interest will also continue is a foregone conclusion. His zeal to know is unquenchable, and he recognizes the challenge of the future as great impending events in technology cast their shadows before them.

IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

RADIATION TREATMENT OF FOODS [a]

Potential—But Still in the Future

L. E. CLIFCORN

Research Associate, American Can Company and President, Institute of Food Technologists

IN THE FIVE MILLION DOLLAR, five year Quartermaster Food and Container Institute program for the preservation of foods by ionizing radiations, more concentrated research effort is being applied than ever to any other method of food preservation. The reasons for this are easily understood when one considers the complexities of the process and its effect on the chemistry of foods. In addition, the safety criteria for the Food and Drug Administration (civilian) and Surgeon General (military) acceptance of a new process for food preservation justifiably present time consuming and expensive investigations to prove non-toxicity.

Nevertheless, authorities are convinced that patience and persistent research will produce important contributions to food preservation. The military objectives of the QMF&CI program are space and weight saving, extended storage life and increased acceptability of some ration items. Col. W. D. Jackson, Chief of the Research and Development Division of the Office of the Quartermaster General has cited three vital areas that will benefit if radiation processing proves practical:

Quoted from *Nucleonics (1)*

1. "Subsistence procurement—example: The shipping cost from Chicago to Tokyo is 8.7 cents/lb. for frozen meat and 3 cents for nonperishables. When possible, each man receives 6.0 lbs. of food per day, 2.7 lbs. of which are perishables (roughly 2.3 lbs. of the latter shipped from the U. S.). Thus, perishables impose an additional shipping cost of 11 cents per man per day.
2. "The supply system for the armed forces is geographically extensive. Supplying perishables to overseas areas involves warehouses, railroad reefer cars, refrigerator ships, trucks, and trailers. Radiation processing could relieve the congestion of machinery-laden naval vessels and ameliorate the expense of static refrigerated facilities.
3. "Food quality or quantity is a controlling factor in the success of many tactical operations. Reduction in the frequency of resupplying warships with perishables would increase their cruising range—particularly in the case of nuclear-powered vessels."

Thus, military needs may provide the impetus to commercial applications of this method of food preservation.

The first work on the application of radiations to food preservation was done in the early 40's. In 1948 there were three laboratories conducting research on cold sterilization, by 1950 there were ten and in 1955 there were over twenty-five laboratories or groups. When we look at the history of other methods of food preservation we should not be impatient with fifteen years of accomplishment.

The art of canning was discovered 150 years ago by Nicholas Appert, but it was not until 50 years later that

(Continued on page 36)

[a] Presented by Dr. L. E. Clifcorn, president of the Institute of Food Technologists, before the January 18 meeting of the New York Section of IFT.

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Cake Mixes												
Dough and Batter	√	√	√	√				√				
Emulsions	√		√	√			√					
Icings and Toppings	√	√	√	√	√			√		√		
Jellies	√		√		√			√		√		
Pie Fillers	√	√										
Mince Meat												
BOTTLERS FLAVORS	√	√	√				√*		√	√	√		√
CANDY AND CONFECTIONERY	√	√		√	√	√		√		√		
Coatings				√				√				
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Gums and Jellies	√	√			√					√		√
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CONDIMENTS												
Pickles and Relishes												
Salad Dressings												
Sauces and Catsup												
CORDIALS AND LIQUEURS									√	√	√	√
DIETETIC AND LOW CALORIE FOODS												
FROZEN FOODS												
HOUSEHOLD EXTRACTS	√	√	√				√		√	√		
ICE CREAM AND PUREES	√	√								√	√	
Water Ices												√
MEAT AND POULTRY PRODUCTS												
OLEOMARGARINE												
PHARMACEUTICALS	√											
Dental and Oral Preparations												
PUDDINGS AND GELATINE DESSERTS	√	√	√									
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(Continued from page 32)

Louis Pasteur brought about understanding of the process through his bacteriological discoveries. A tremendous amount of further research over many years is responsible for the development of our canning "know-how" as it is employed today. Similarly, the first successful mechanical refrigeration unit was made in the late 1800's but it was not until the early 1930's that mechanical refrigeration made any commercial contribution to the preservation of foods. Concentrated effort on radiation research should materially shorten the time to develop practical applications. The basic fact remains that foods treated by radiations can be sterilized at energy levels which do not heat the foods significantly and in many instances do not change the quality characteristics materially. Even the most conservative critics of the large scale attention being given to radiation research on foods should, if there is anything here in the form of a great discovery, want us Americans to find it first. It would be a great contribution to the Atoms for Peace Program.

Above all, radiation treatment of foods must not be oversold as a process which will revolutionize present methods of preservation of foods. The irradiation process costs more—initial installations running to several hundred thousand dollars—and operating costs for sterilizing doses are estimated at 2 to 5 cents a pound compared to steam at .01 to 0.1 cent a pound. Definite advantages must be offered to justify any added cost for irradiation treatment. Careful analyses have been made of food commodities from both a military and civilian standpoint.

Some elements of progress. The most promising area from a military standpoint is that of the meat items. At sterilization levels of irradiation, the products whole ham, bacon, pork, pork sausage, beef liver, cod fish cakes and chicken are acceptable from a flavor standpoint *(2)*. Sterilized whole ham is not feasible by heat sterilization methods. The extension of refrigeration storage life is of both military and civilian interest. The Massachusetts Institute of Technology group *(3)* has shown that the organoleptic quality of sausage patties irradiated at one million rep and stored 14 weeks at 36-40° F. was better than the non-irradiated control stored at 0° F. By a similar treatment, ground beef was extended in storage life to 12 weeks. Pasteurization treatments of prepackaged meats at levels up to 60,000 rep have produced no significant off-flavors and have extended refrigeration life five to twenty times *(4, 5)*.

Figures 1 through 4 make visual the effects of radiation on a selection of products. These figures must not be construed to mean that the irradiated foods shown are examples of a perfected process. They only depict the results of experimental application of radiation to some familiar foods. Analytic evaluations alone will be able to tell the whole story. Fortunately, such evaluations are now appearing in quantity.

Other contributions offer (a) a means of inhibition of potato sprouting, (b) a method of producing salmonella-free dried eggs, (c) a method for destruction of insects and their larvae, (d) a method for destroying trichinae in pork and (e) a method of surface treatment of fruits and vegetables for extended storage life. Increased storage life of potatoes is of particular interest to the military since loss through spoilage in shipment to military theatres is very high.

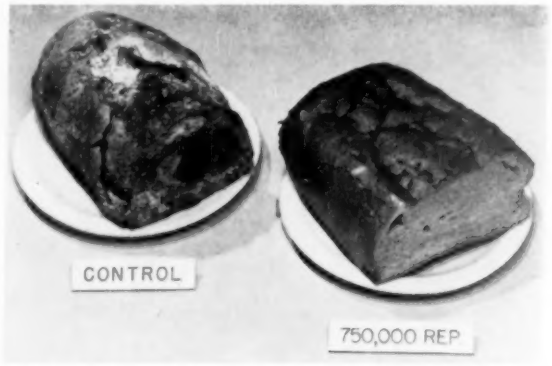

Figure 1. Rye bread—four months at room temperature.

Reports from many collaborators of the QMF&CI program doing work on the wholesomeness of radiation treated foods, including those from the Army Medical Nutrition Laboratory *(6)* using human subjects, report no indication of any harmful effects. The fifteen foods in the human feeding studies all had an irradiation dose of 3×10^6 rep. Surprisingly, at this dosage the foods were favorably acceptable to the nine human subjects on the test.

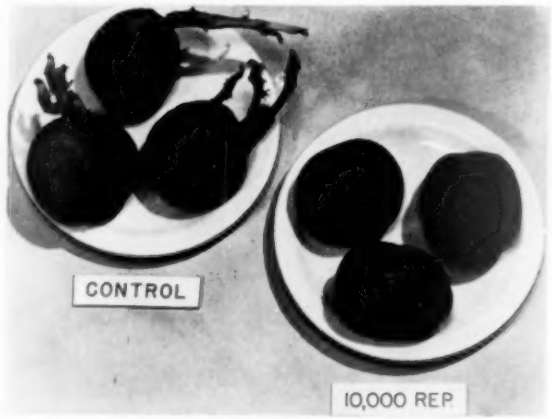

Figure 2. Potatoes—a light dose inhibits sprouting.

Effects. Although it is true that the nature of the effects of radiations on foods can not be materially changed, it is possible to control undesirable off-flavor producing changes to some degree. The following reaction shows the changes taking place in water when bombarded by ionizing radiations:

$$HOH + e \longrightarrow H\cdot + OH$$
(free radicals)

The free radical OH· is oxidative and produces peroxides and many unknown chemical changes in foods. Many laboratories are studying these changes in fat,

(Continued on page 40 following technical papers)

The Antioxidant Properties of Spices in Foods[a, b, c]

J. R. Chipault, G. R. Mizuno and W. O. Lundberg
The Hormel Institute, University of Minnesota, Austin, Minnesota

(Manuscript received November 21, 1955)

PREVIOUS STUDIES *(2, 3)* have shown that the antioxidant effectiveness of spices depends to a large extent on the type of substrate in which they are used. In general, spices are more effective in a simple fat-water emulsion system than in dry lard, and more effective in dry lard than in baked pie crust. Further, however, if the spices are arranged in the order of their effectiveness, the arrangement is found to vary with the type of substrate used. Many fat-containing food products in which spices are used have a fat phase in intimate contact with an aqueous phase. Other factors, such as the physical state of the fat-water system, the kind of fat, pH of the aqueous medium, the presence of other substances (e.g., prooxidants, antioxidants, synergists) affecting the stability of fats, may markedly influence the antioxidant effects of spices in different foods.

DuBois and Tressler *(4)* reported that black pepper, sage, mace and ginger retarded the development of rancidity in frozen ground pork and beef. Black pepper, red pepper, and sage were found to increase the storage life of frozen pork sausage by Atkinson, Cecil, Woodroof and Shelor *(1)*. The antioxidant properties of other spices in food products have apparently not been determined previously. In this study 17 spices, selected on the basis of their antioxidant effects in lard, baked pie crusts and fat emulsions in water, were studied in ground pork and mayonnaise. Four of the spices were further studied in a second mayonnaise formulation and in a French dressing.

In the results reported here, the antioxygenic activity of the spices has been expressed in terms of an antioxidant index which is the ratio of the stability of the sample containing the spice to the stability of a control sample in which no spice was present.

ANTIOXIDANT PROPERTIES OF SPICES IN GROUND PORK

Preparation of samples. The samples were prepared from 20 lbs. of fresh ground pork containing about 40% moisture and 50% fat. For each spice, 400 g. of ground pork was spread evenly on a sheet of locker paper to a thickness of about ⅜ inch. Salt (1.25%) and ground spice to the extent of 0.5% were sprinkled evenly on the surface and the layer of ground meat folded back on itself ⅓ of the way from each edge. The meat was then again spread with the help of a wire S-shaped potato masher and the process of folding and spreading was repeated 3 additional times. The mixture was then divided into 20 patties of approximately 20 g. each. The patties were wrapped individually in locker paper and half of them were stored at —5° C. and the remainder at —15° C. In addition to the 17 individual spices studied, a sample containing sage (0.25%), black pepper (0.25%) and red pepper (0.15%) was also prepared.

From time to time a patty was extracted with chloroform in a Waring blender and, after drying the chloroform solution over anhydrous sodium sulfate, aliquots were taken for the determinations of peroxide value, acid value, and spectral absorption at 232 mμ. The concentration of fat in the chloroform extract was also determined separately by removing the solvent from a portion of the extract. Peroxides were determined by an iodimetric method *(5)* on a 10 ml. aliquot of the chloroform extract to which 15 ml. of glacial acetic acid was added. Free fatty acids were measured by titrating 10 ml. of chloroform extract diluted with 10 ml. of alcohol with 0.1 N NaOH. For the determination of spectral absorption, 1 ml. of chloroform extract was evaporated in a 10 ml. volumetric flask and the fat residue was dissolved in ethyl ether.

Results and discussion. The development of peroxides took place in an autocatalytic manner. The time required for the fat to reach a peroxide value of 20 m.e./kg. was taken as a measure of stability.

Free fatty acids developed very slowly in all the samples. Samples containing white pepper or black pepper stored at —5° C. developed free fatty acids somewhat more rapidly than the control. At —15° C., however, only white pepper appeared to accelerate slightly the formation of free fatty acids. The other spices had no significant effect on the development of acidity. Spectral absorption at 232 mμ increased with time of storage but the changes in spectral absorption were more erratic and less pronounced than those in peroxide contents.

The effectiveness of the various spices in preventing peroxide development in ground pork is shown in Table 1. The relative efficiency of the spices was approximately the same at both storage temperatures with the exception of oregano which was more effective at —5° C. and the spice mixture which was more effective at —15° C. Cardamom, cassia, and cinnamon, were slightly prooxygenic while mustard, black pepper, white pepper and savory were inactive or nearly so. Ginger had a slight protective effect and mace, nutmeg, thyme and turmeric were quite effective in preventing peroxide development. Samples containing allspice, cloves, rosemary and sage still had peroxide values below 20 m.e./kg. after storage periods of 36 weeks at —5° C. and 96 weeks at —15° C.

TABLE 1
Antioxidant properties of spices in ground pork at —5° and —15° C.

Spice	Antioxidant index [1]	
	—5° C.	—15° C.
Allspice	>5.3[2]	>10.0[4]
Cardamom	0.9	0.8
Cassia	0.9	0.7
Cinnamon	1.0	0.8
Cloves	>5.3[2]	10.0[4]
Ginger	1.3	1.5
Mace	2.6	3.1
Mustard	1.2	1.1
Nutmeg	5.3	2.6
Oregano	>7.2[3]	3.7
Black pepper	1.1	1.0
White pepper	1.0	1.0
Rosemary	>5.3[2]	>10.0[4]
Sage	>5.3[2]	>10.0[4]
Savory	1.0	1.0
Thyme	6.0	3.2
Turmeric	4.5	3.4
Spice mixture [5]	4.6	>10.0[4]

[1] Control stabilities were 6.7 weeks at —5° and 9.7 weeks at —15° C.
[2] Peroxide values: allspice 9.1; cloves 1.0; rosemary 2.2; sage 12.8 after 36 weeks.
[3] Peroxide value: 3.0 m.e./kg. after 48 weeks.
[4] Peroxide values: allspice 18.0; cloves 2.8; rosemary 6.0; sage 8.2; spice mixture 10.0 m.e./kg. after 96 weeks.
[5] Sage (0.25%) black pepper (0.25%) and red pepper (0.15%) in salted (1.25%) ground pork.

[a] Hormel Institute publication no. 137.

[b] Presented at the 14th Annual Meeting of the Institute of Food Technologists, June 27-July 1, 1954, Los Angeles.

[c] This work was aided by grants from the American Spice Trade Association and the Hormel Foundation.

ANTIOXIDANT PROPERTIES OF SPICES IN MAYONNAISE

Preparation of samples. Two mayonnaise formulas were used. Seventeen spices were tested in mayonnaise A, and 4 of these were further studied in mayonnaise B.

Mayonnaise A: A large batch of mayonnaise was prepared from 1440 ml. of corn oil, 300 g. of fresh egg yolk, 133 ml. of distilled water, 268 ml. of 5% acetic acid, 28 g. of salt, and 2 g. of benzoic acid added as a preservative. The oil and acetic acid were alternately added in two portions to the rest of the ingredients in a household mixer. Fifty-gram samples of the mayonnaise were placed in 4 oz. wide-mouth screw cap bottles and 66 mg. of spice added and mixed well with the mayonnaise giving a spice concentration of approximately 0.2% based on the fat in the mayonnaise.

Mayonnaise B: Four grams of salt and 6 g. of sugar were dissolved in 30 g. of 45 grain vinegar. Fifty-five grams of corn oil and 1.23 g. of spice were shaken with this solution and the mixture in turn was mixed with a whole egg in a Waring blender for 5 seconds. An additional 163 g. of corn oil was then added slowly in the blender and incorporated into the emulsion. In this mayonnaise the spice concentration was 0.56% based on the fat present. A separate batch of mayonnaise was prepared for each spice. Fifty-gram samples of each batch were stored in 4-oz. wide-mouth screw cap bottles.

The various samples of mayonnaises A and B were tested by following the development of peroxides during storage at room temperature in the dark. Peroxide values were determined iodimetrically as follows: A 2-gram sample of mayonnaise was mixed thoroughly for 3 or 4 minutes with an equal weight of anhydrous $MgSO_4$. After standing for 30 minutes the $MgSO_4$ mixture was moistened with a few ml. of peroxide solvent (Acetic Acid: Chloroform, 3:2) and crushed with a stirring rod to a thin smooth paste. The remainder of a total of 17.5 ml. of solvent was stirred in and the mixture allowed to stand for 30 minutes with occasional stirring. A saturated KI solution (0.5 ml.) was then added and, after 2 minutes, 30 ml. of water were added just prior to titration with 0.01 N thiosulfate. The presence of magnesium sulfate during the determination resulted in peroxide values that were about 6% lower than those found when the fat was completely extracted from the mayonnaise, dried, and the solvent removed prior to the determination. This difference was considered to be of no significance for the purpose of this study.

Corn oil is usually not regarded as rancid until it has reached a peroxide value of approximately 80 to 100 m.e./kg. Since these studies are not accelerated stability tests, but rather tests under ordinary storage conditions at room temperature, the experiment would have continued for an unduly long time if the samples had been stored until the mayonnaise actually became rancid. For comparative purposes, therefore, the time required for the oil in the mayonnaise to reach a peroxide value of 20 m.e./kg. was arbitrarily taken as a measure of stability. With corn oil, this peroxide level represents an early stage in the induction period. The stability determined in this manner is more a measure of the initial rate of peroxide formation than of the time required before rapid, autocatalytic oxidation occurs, and may not be an accurate measure of the over-all antioxidant potency of the spices tested. In general, however, it is usually found that a low initial rate of peroxide formation is associated with a high resistance to rancidity.

Results and discussion. The results, in terms of antioxidant indexes, are shown in Table 2. Seven spices were effective in retarding peroxide development in mayonnaise. Savory, which was only slightly effective, was not effective in sausage. On the other hand, ginger, mace, nutmeg and turmeric, which improved appreciably the stability of frozen ground pork, had no effect in mayonnaise. Oregano showed the strongest antioxidant activity in mayonnaise, whereas cloves and allspice, previously found to be the two best antioxidants in simple oil-in-water emulsions, were only slightly effective in mayonnaise. Mace, nutmeg, and turmeric were slightly prooxygenic in mayonnaise although they were strongly antioxygenic in the oil-in-water system.

TABLE 2
Antioxidant properties of spices in mayonnaise

Spice	Antioxidant index [1]	
	Mayonnaise A	Mayonnaise B
Allspice	1.4	3.1
Cardamom	1.0	
Cassia	1.0	
Cinnamon	1.0	
Cloves	2.0	4.6
Ginger	1.0	
Mace	0.9	
Mustard	0.9	
Nutmeg	0.9	
Oregano	8.5	9.1
Black pepper	1.0	
White pepper	0.9	
Rosemary	2.2	
Sage	2.4	3.4
Savory	1.5	
Thyme	1.8	
Turmeric	0.9	

[1] Control stabilities were 21 days for mayonnaise A and 48 days for mayonnaise B.

Mayonnaise B was more stable than mayonnaise A. The two mayonnaises differed in the manner in which they were prepared as well as in composition, and it is impossible to relate the higher stability of mayonnaise B to any particular factors.

ANTIOXIDANT PROPERTIES OF SPICES IN FRENCH DRESSING

Preparation of samples. A separating type of French dressing was prepared according to the following formula: Vinegar (30 grain) 42.5%, salt 5%, sugar 1%, spice 0.5%, and corn oil 51.0%. The sugar, salt, and spice were first added to the vinegar and then the oil was added and shaken vigorously for one minute. Allspice, cloves, oregano and sage were used in this experiment. Fifty-ml. samples of each preparation were held at 37° C. and 63° C. in 4-oz. screw cap bottles. The samples were shaken once daily for 10 seconds. At appropriate intervals 1 ml. of the supernatant oil was removed for iodimetric peroxide determination. A proportionate amount of the lower aqueous layer was also removed and discarded to keep the ratio of oil to vinegar constant.

Results and discussion. The oil in the French dressing oxidized considerably faster than the same oil in the mayonnaise samples. The French dressing samples attained peroxide values of 90 m.e./kg. of fat in a reasonable length of time and therefore the stability in each case was taken as the time required to reach a peroxide value of 90 m.e./kg. The peroxide development curves for sage and oregano at 63° C. showed an autocatalytic character. The curves for cloves and sage at 37° C. showed a slightly decreasing rate of peroxide formation with time, which may perhaps be due to a low diffusion rate of the antioxidants from the spice particles into the oil. With all other samples, peroxides developed at a constant rate giving a straight line relationship between peroxide value and time.

The oregano French dressing at 37° C. had the lowest rate of peroxide accumulation. The results expressed as antioxidant indexes are shown in Table 3. Again oregano is the best antioxidant in this product and sage and cloves are also quite effective, whereas allspice is only slightly antioxygenic.

TABLE 3
Antioxidant properties of spices in French dressing

Spice	Antioxidant index [1]	
	37° C.	63° C.
Allspice	1.1	1.2
Cloves	2.0	1.2
Oregano	2.6	2.4
Sage	2.2	2.2

[1] Control stabilities were 23.4 days at 37° C. and 8.0 days at 63° C.

TABLE 4
Antioxidant properties of several spices in 6 substrates

	Lard	Pie crust	Emulsion	Ground pork		Mayonnaise		French dressing	
				−5° C.	−15° C.	A	B	37° C.	63° C.
Spice concentration in fat (%)	0.2	0.2	0.1	0.25	0.25	0.20	0.56	1.0	1.0
Antioxidant indexes:									
Allspice	1.8	1.1	16.7	>5.3	>10.0	1.4	3.1	1.1	1.2
Cloves	1.8	1.3	85.8[1]	>5.3	>10.0	2.0	4.6	2.0	1.2
Oregano	3.8	2.7	7.9	>7.2	3.7	8.5	9.1	2.6	2.4
Rosemary	17.6	4.1	10.2	>5.3	>10.0	2.2	—	—	—
Sage	14.2	2.7	7.8	>5.3	>10.0	2.4	3.4	2.2	2.2
Thyme	3.0	1.9	6.8	6.0	3.2	1.8	—	—	—

[1] Average of 3 determinations.

CONCLUSIONS

An examination of all the accumulated data from this and previous studies in this laboratory reveals that of 17 spices tested in 5 substrates, only 6 spices were found to have antioxidant properties in all the substrates. Four of these were further examined and found to be effective also in a sixth substrate.

Table 4 is a summary of the antioxidant indexes found with these 6 spices on all the substrates studied. The indexes obtained with the different substrates cannot be compared directly because the spice concentrations were different for several of the substrates and the peroxide values selected as end points were also different with different substrates. However, the spices may be compared among themselves for each substrate. The order of effectiveness of the spices varied with the substrate used. One of the more important points derived from these data is that it is unwise to predict the antioxidant properties of a spice in any given food product from the results obtained in some different substrate. However, a few observations, somewhat speculative in nature, may be made from these studies to point out possible areas of future investigation.

The substrates that have been used in the various studies with spices in this laboratory may be classed in 3 groups. The first type is represented by lard, a single phase dry fat containing little natural antioxidant and possessing a relatively low stability. Sage and rosemary are by far the most effective antioxidants in this substrate, indicating that possibly these two spices contain powerful phenolic type, primary antioxidants that are quite stable at high temperatures (98.6° C.).

The pie crust, oil-water emulsion and ground pork substrates are all representative of biphasic or multiphasic systems that contain some water and in which the fat is also nearly free of natural antioxidants and has a relatively low resistance to oxidation. In these substrates sage and rosemary are again quite effective, but oregano is also very effective. In addition, clove is by far the most effective as an antioxidant in the simple emulsion system and in ground pork.

Cloves, however, are rather ineffective in pie crusts. The latter substrate differs from the oil-water emulsion and ground pork in having been subjected to high heat for some time. Perhaps the compounds responsible for the antioxidant properties of cloves are heat-sensitive. This possibility is further supported by the observation that cloves are less effective in French dressing stored at 63° C. than in the same substrate stored at 37° C. Allspice is also effective in the oil-water emulsion and in ground pork although it has little effect in pie crust.

The mayonnaise and French dressing represent another type of water-fat multiphasic system in which the fat contains appreciable amounts of natural antioxidant and has a high stability. In this system the antioxidants already present in the fat tend to mask the effects of added antioxidants. Oregano is the most effective spice in this system. Possibly oregano contains antioxidants of the synergist type which reinforce the antioxidants that are present originally in the fat.

SUMMARY

The antioxidant properties of spices have been studied in ground pork, two types of mayonnaise and a French dressing. Allspice, cloves, sage, oregano, rosemary, and thyme increased the stability of all the fat substrates in which they were tested, but the relative effectiveness of the spices varied with the different substrates. Sage and rosemary have previously been found to be much more effective than the other spices in lard alone. Cloves were a powerful antioxidant in simple oil-water emulsions and in ground pork. Oregano was most effective in mayonnaise and French dressing.

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A Procedure for Sampling and Grading Raw Green Asparagus[a]

(Manuscript received January 18, 1956)

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EXISTING PROCEDURES for sampling green asparagus usually consist of the drawing of a sample of approximately six pounds from one or more of the field boxes or crates in which the raw asparagus is shipped to the buyer or processor, without definite instructions as to how this six-pound sample is to be collected *(5, 6)*. Although it is generally recognized that fibrousness, or toughness is an important factor of quality *(1, 4)*, no estimate of this factor is included in the U. S. Grade for green asparagus. Present criteria include only a determination of stalk diameter, the percentage of the stalks beyond a certain length, say 7.0 inches, and the percentage of cull material—which may consist of stalks that show insect damage, spreading tips, or those that are wilted or flabby, dirty or sandy, badly misshapen, or insufficient as to color *(5, 6)*.[b]

The purpose of this study, therefore, was (a) to determine how much asparagus drawn from how many boxes would constitute the most economic sample, and (b) to design a grading procedure that includes information on fibrousness in addition to the information currently provided on culls and excessive length of stalks.

MATERIALS AND METHODS

During the asparagus processing seasons of 1953 and 1954, 35 loads of asparagus which were delivered to processing plants in Maryland, Delaware, and New Jersey were sampled and graded in accordance with the U. S. grades, for percent U. S. 1 and 2 culls, and butts *(6)*,[c] and for fibrousness by the use of the Shear-press *(7)*. From each load, 5 types of samples were drawn in duplicate, for a total of 10 individual samplings, each consisting of 6 pounds of asparagus. The 5 types of samples were drawn as follows: (a) 6 pounds from one box; (b) 2 pounds from each of 3 boxes; (c) 1 pound from each of 6 boxes; (d) one-half pound from each of 12 boxes; and (e) about 3 ounces from each of 36 boxes. The samples were obtained at approximately equal intervals as the trucks were unloaded. Thus, for the smaller loads consisting of about 100 boxes, a few ounces of asparagus were drawn out of approximately every third box for sampling (c), and a half pound sample from every eighth box for sampling (d), etc. Duplicate samples were drawn from different boxes. The stalks were removed in as random a manner as possible without actually looking at the individual stalks as they were drawn.

Each of the 10 samplings containing approximately 6 pounds was collected in one container and submitted to an official U. S. grader who provided a U. S. grade in accordance with routine procedure. The actual values used in the following calculations were in terms of U. S. equivalent scores, consisting of percent U. S. No. 1, plus percent U. S. No. 2 x 0.5,[c] with the culls and butts equated to 0.0. Average U. S. scores for these 35 loads ranged from 48 to 85%.

The same material was then mixed thoroughly, and 5 replicate shear-press readings were obtained at a point 6 inches from the tip, and again 4½ inches from the tip. The average shear-press values at the 6-inch distance from the tip were then used in the subsequent calculations. Average shear-press values for these 35 loads ranged from 55 to 430 at the 6-inch length, and 17 to 136 at the 4½-inch length.

Errors in terms of standard deviations for each of the 5 types of samplings were determined by calculating the standard error of the difference between each individual determination and the average of the 10 determinations for each load, which was taken as the true value for the load.

RESULTS AND DISCUSSION

Since this problem of how much asparagus out of how many boxes or crates will provide the most efficient sample is identical to the tomato sampling problem which has been reported previously *(2)* it was handled similarly. As was found with the tomatoes, the best correlation between the numbers of boxes from which the 6-pound sample was removed, and the standard error, was obtained when the numbers of boxes were transformed to their log log's, as shown in Table 1.

TABLE 1
Correlations between numbers of boxes from which the sample is removed and standard error

	U. S. Score	Shear-press
Number of boxes x standard error	—.752	—.722
Log of number of boxes x standard error	—.960	—.957
Log Log of number of boxes x standard error	—.989	—.988

This relationship is shown in graphic form in Figure 1, along with the estimated cost of sampling. The efficiency index for any particular method of obtaining the 6-pound sample can then be calculated by reading the appropriate standard error from the curves in Figure 1.

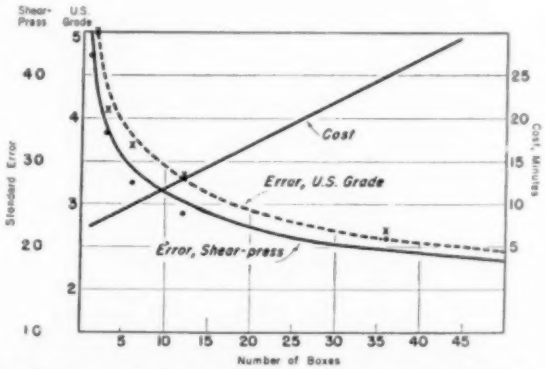

Figure 1. Effect of number of boxes from which the six-pound sample is obtained on the sampling error, and the cost of sampling.

[a] Scientific Article No. A525, Contribution No. 2657 of the Maryland Agricultural Experiment Station (Department of Horticulture). Partial support from funds provided under the Research and Marketing Act of 1946, Project NEM3.

[b] U. S. Standards include instructions for sampling in their general handbook, and provide for scoring tough or fibrous stalks as one of the factors which materially affect freezing or canning quality.

[c] Where a separate determination of U. S. 2 grade is not made, this part of the calculation may be ignored.

for any given number of boxes from which the sample is drawn. A number of such calculations of the efficiency index are given in Table 2 for the U. S. score data, and in Table 3 for the shear-press data. These

TABLE 2

Relative efficiency of different sampling methods of grading of green asparagus for processing (U. S. grades)

1 No. of boxes	2 Lbs. from each box	3 Standard error (s)	4 Cost as minutes labor [1]	5 Number of samplings for 3 point error [2] (N)	6 Efficiency index [3]
1	6	5.6	10.5	3.49	36.6
3	2	4.4	11.5	2.17	25.0
5	1.2	3.9	12.5	1.69	21.1
8	.75	3.35	14.0	1.40	19.6
10	.60	3.4	15.0	1.28	19.2
12	.50	3.3	16.0	1.18	18.9
15	.40	3.1	17.5	1.08	18.9
20	.30	2.9	20.0	0.97	19.4
25	.24	2.8	22.5	0.87	19.6

[1] Cost estimated as follows: 10 minutes required to handle 6 lb. sample, + 0.5 minutes to handle each box.
[2] Calculated as $N = (s/3)^2$
[3] Calculated by multiplying columns 4 x 5.

TABLE 3

Relative efficiency of different sampling procedures for grading of green asparagus for processing (Shear-press values)

1 No. of boxes	2 Lbs. from each box	3 Standard error (s)	4 Cost as minutes of labor [1]	5 Number of samplings for 20 lb. error [2] (N)	6 Efficiency index [3]
1	6.0	45	7.5	5.06	38.0
3	2.0	34	8.5	2.89	24.6
5	1.2	30	9.5	2.35	21.4
8	0.75	28	11.0	1.89	20.8
10	0.60	26	12.0	1.69	20.3
12	0.50	25	13.0	1.56	20.3
15	0.40	24	14.5	1.44	20.6
20	0.30	22	17.0	1.21	20.9
25	0.24	21	19.5	1.10	21.5

[1] Cost estimated as follows: 10 minutes required to handle 6 lb. sample + 0.5 minutes to handle each box.
[2] Calculated as $N = (s/20)^2$
[3] Calculated by multiplying columns 4 x 5.

results are shown in graphic form in Figure 2, where it may be noted that a most efficient sampling procedure suitable both for the U. S. Grade for defects as well as for the shear-press determination for fibrousness, would be the removal of the 6-pound sample from 12 boxes, or one-half pound per box.

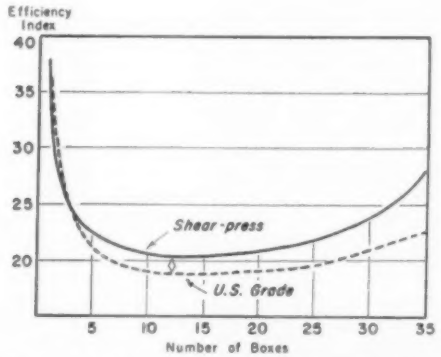

Figure 2. Effect of number of boxes from which the six-pound sample is obtained on the efficiency index. A lower efficiency index indicates a more economical sampling procedure.

It may be further calculated on the basis of the data obtained on these 35 loads, that a sample of 6 pounds of asparagus obtained from 12 boxes, will reduce the U. S. Grade sampling error to approximately 3 score points. However, if 6 pounds of asparagus are to be removed from only one box the anticipated error will be above 5 points, and if precision is to be increased to the 3-point level, this procedure of 6 pounds from one box will need to be repeated 3½ times.

Other comparisons of the above two methods are presented in Table 4 for the U. S. scores, and in Table 5 for the shear-press.

Sampling tables usually take into consideration lot size, on the assumption that greater precision is desirable when more is at stake *(3)*. Considering the

TABLE 4

Weight of sample and numbers of boxes required for obtaining different degrees of precision in the grading of green asparagus (U. S. score)

Precision as		Lbs. removed per box	Number of boxes	Total weight of sample
Points U. S. score	% error [1]			
1.0	2	0.5	131	65.5
		6.0	31	186.0
1.5	3	0.5	58	29.0
		6.0	14	84.0
2.0	4	0.5	33	16.5
		6.0	8	48.0
2.5	5	0.5	21	10.5
		6.0	5	30.0
3.0	6	0.5	14	7.0
		6.0	3.5	21.0
4.0	8	0.5	8	4.0
		6.0	2	12.0
5.0	10	0.5	5	2.5
		6.0	1	6.0

[1] Since the range of U. S. Score equivalents was approximately 50 score points, precision on a percentage basis was obtained by multiplying the score points by 2.

TABLE 5

Weight of sample and numbers of boxes required for obtaining different degrees of precision in the grading of green asparagus (Shear-press)

Precision as		Lbs. removed per box	Number of boxes	Total weight of sample, lbs.
Lbs. shear-press	% error [1]			
8	2	0.5	117	58.5
		6.0	32	192.0
12	3	0.5	52	26.0
		6.0	14	84.0
16	4	0.5	29	14.5
		6.0	8	48.0
20	5	0.5	20	10.0
		6.0	5	30.0
24	6	0.5	13	6.5
		6.0	3.5	21.0
32	8	0.5	7	3.5
		6.0	2	12.0
40	10	0.5	5	2.5
		6.0	1	6.0

[1] Since the range of Shear-press values was approximately 400 lbs., precision on a percentage basis was obtained by dividing lbs. Shear-press by 4.

results obtained both for the U. S. scores and for the shear-press, sampling procedures and sizes are suggested for different size loads in Table 6. In each case, one-half pound of asparagus is to be removed from each box.

TABLE 6
A suggested sampling table for green asparagus

Lot size as no. of boxes per load	No. of boxes from which 0.5 lbs. are drawn	Total wt. of sample lbs.	Anticipated precision as % error
Up to 20	5	2.5	10
21 to 50	8	4.0	8
51 to 100	14	7.0	6
101 to 200	20	10.0	5
201 to 500	30	15.0	4
501 and over	50	25.0	3

SUMMARY OF RECOMMENDED PROCEDURES FOR GRADING GREEN ASPARAGUS

1. Obtain a 2 to 25 lb. sample of asparagus, depending on lot size, as indicated in Table 6.
2. Cut all stalks to contracted length, determine percent butts by weight.
3. Determine percent culls, including insect damage, spreading tips, wilted or flabby, dirty or sandy, badly misshapen, or insufficient color.[a]
4. Discard butts and culls, and run one shear-press determination per each pound of the remaining material, at the six-inch point.
5. Calculate score according to the following example:

	Pounds
Weight of lot of asparagus	500
Weight of butts—3%	15
Weight of culls—6%	30
Weight of U. S. No. 2 x 0.5—6%[b]	30
Net weight of usable asparagus	425[b]
Average shear-press value	135

Data in Table 7 show the relationship of shear-press readings to fiber content, and to the acceptability of the asparagus, at the point on the stalk where the shear-press readings are obtained. Thus, the value of the shear-press grade as obtained at the 6-inch length is primarily as an indicator of the quality of the cuts after the upper portion of the stalk has been removed. If it is desired to obtain more specific information on the fibrousness of the whole spear pack, a second reading should be obtained at the length of the stalk that is to be so packed—say 4.5 inches for canned asparagus, or 5.0 inches for frozen asparagus *(7)*. The size factor has not been considered in this procedure. It should be considered when included in grower-buyer contracts.

[a] Where purple coloration interferes with a clear-cut decision as to where green color ends, blanch stalk butts in hot water for one minute, or if that is not feasible, allow green color for ½ inch below beginning of purple zone *(1)*.

[b] Hence payment will be made for 425 pounds of asparagus having a shear-press grade of 135.

TABLE 7
Relation of Shear-press values on raw asparagus to fiber content and acceptability

Shear-press value, lbs.	Fiber, %	Remarks
100	0.10	Very tender
125	0.20	Tender
150	0.30	Slightly fibrous
175	0.40	Fibrous
200	0.50	Suggested as substandard
225	0.60	limit for frozen stalks
250	0.70	Acceptable only as cuts
275	0.80	Doubtful acceptability
300	0.90	in any style pack
325	1.00	

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A Study of the Effects of Aureomycin-Containing Sea Water and Ices Upon The Storage Life of Round Herring

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INTEREST HAS ARISEN in recent years in the preservation of sea foods with antibiotics. Tarr and associates *(5)* reported that, of several antibiotics studied, only Aureomycin, Terramycin, and Chloromycetin were found effective inhibitors of the natural mixed bacterial flora. Further studies *(6, 7)* revealed that spoilage of whole eviscerated fish was significantly reduced by ice containing Aureomycin, by holding the fish in sea water containing the antibiotic, or by immersion in an Aureomycin solution. Farber *(2)* has reported additional evidence for the effectiveness of dips in Aureomycin-brine solutions on the storage life of fillets of several fishes. He found, however, that dips in Aureomycin were ineffective in the preservation of shrimp. Tomiyama *et al. (8, 9)* have recently reported that a 30-minute dip in a 5% brine solution containing 10 p.p.m. Aureomycin was markedly effective in prolonging the storage life of round fish procured from local fish markets. They assumed that even greater results would be obtained if the fish were treated immediately after capture.

The present investigation studied various possible procedures for the treatment of fish with Aureomycin on a practical scale, aboard ship immediately after catching and/or on shore after landing.

EXPERIMENTAL METHOD

Types of Aureomycin preparations used. Three types of Aureomycin preparations were used. (a) Aureomycin A (AM-A): An intermediate product in the purification process of pharmaceutical Aureomycin having a purity of 90.6%. The preparation is a product of the Japan-Lederle Co. (b) Acronize B_1: A preparation made by the Fine Chemicals Division of American Cyanamid Co. for use in making Aureomycin-ice. It contains an ingredient helpful for the dispersion and dissolution of Aureomycin. The Aureomycin content of the sample was 16.5%. Ice containing 5 p.p.m. Aureomycin was prepared by adding a suspension containing 4.5 g. of Acronize B_1 in 500 cc. of water to 300 lbs. water in an ice can. The solution was aerated for about 30 minutes and then frozen, yielding a homogeneous ice containing 5 p.p.m. Aureomycin. (c) Acronize PD: A preparation made by the Fine Chemicals Division of the American Cyanamid Co. It contains Aureomycin at a 10% level and an acidic ingredient for regulating the pH of sea water to approximately 6.

Procurement of sample fish. The fish were obtained in two hauls by a purse-seine on July 29, 1955, in the Amakusa Sea area, 10 miles SE of Ushibuka, Kyushu, Japan. The fish were principally Pacific round herring *(Etrumeus micropus)*, weighing 18-20 g. each. Approximately 1-2% of the catch were sardines *(Sardinella melanosticta)*. The total catch was 1.5 tons.

Treatment of samples aboard the boat. Four tanks were set up on the boat to accommodate all the experimental groups. All tanks were provided with sea water (approximately equal to ⅓-¼ of the weight of the fish to be stored). To tank (I) sufficient acetic acid was added to adjust the pH to 6-7, followed by the addition of an amount of a 1.5% solution of Aureomycin A in 70% ethanol sufficient to make the concentration in the tank 10 p.p.m. To the second tank (II) Acronize PD was added to a level of 100 p.p.m. The Aureomycin content of this tank was also 10 p.p.m. These two tanks were supplied with ice prepared from Acronize B_1 as described above. The third tank (III) contained an identical solution to that in (I) and was supplied with plain ice. The fourth tank (IV) was used as the control without Aureomycin in the sea water and with plain ice. The ratio of weight of ice to weight of sea water was approximately equal in all tanks.

The first haul of fish (900 kg.) was obtained at 4:30 a.m. and was used for tank (I). The second haul of fish was obtained at 5:10 a.m. and amounted to 600 kg. This lot was divided into three groups; one for tank (II), one for tank (IV) and a small portion for tank (III).

Though the concentration of Aureomycin in the solutions was made to 10 p.p.m., it did not remain constant after the fish were added to the tanks, for the fish were not drained before being put in the tanks and some water undoubtedly was added along with the fish. The amount of ice was not kept constant during transportation to port. Therefore, the temperature of each tank was measured during the transportation. The temperature variations that were observed were nearly comparable for the groups, i.e., 0.8-8° C. for (I), 3-6° C. for (II), 0.3-4° C. for (III) and 0.5-5° C. for (IV).

Treatment of samples after landing. The vessel arrived in port at 6:30 a.m., 2 hours after the first haul, and about 1½ hours after the second haul. Treatments of the tanks after landing are shown in Table I. The fish were placed in wooden boxes with about 3 kg. of appropriate ice per box containing about

TABLE 1
Treatment of samples by experimental groups

Tank no.	Treatment on boat	Treatment after landing		Exptl. group code
		Kinds of ice used	Temperature of storage (° C.)	
I	AM-A was added at a 10 p.p.m. level to sea water, followed by supply of Acronize B_1-ice.	B_1-ice	15–20	1
			−1–2	2
		plain ice	15–20	3
			−1–2	4
		none	15–20	5
II	AM was added in form of Acronize PD, followed by supply of Acronize B_1-ice.	B_1	15–20	6
			−1–2	7
		plain ice	15–20	8
			−1–2	9
		none	15–20	10
III	The same as tank (I) except supply of plain ice.	plain ice	15–20	11
			−1–2	12
		none	15–20	13
IV	Sea water supplied with plain ice.	B_1-ice	15–20	14
			−1–2	15
		plain ice	15–20	16
			−1–2	17
		a 30-min. dip in 10 p.p.m. AM-A and held in plain ice.	15–20	18
		a 30-min. dip in 10 p.p.m. AM-A and held without ice.	15–20	19
		none	15–20	20

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15 kg. of fish. It took about 1½ hours for these operations. The fish boxes in each experimental group were subdivided into two categories, one for a short storage at room temperature and the other for a long storage at a temperature near 0° C. (Table 1). In the case of the short storage periods the fish boxes were stacked in 3 layers and placed on the floor separately according to kinds of ice used, i.e., one place for B_1-ice, another for plain ice, and the last for the control without the Aureomycin-treatment. Since the fish boxes were stacked, care was taken to place vinyl sheets between the boxes as well as over the pile, and further, to change the position of the boxes in the pile as well as the position of the piles every day in order to equalize the ambient conditions as far as possible. It was observed that only 10-20% of the ice supplied remained after a 32-hour storage at the higher temperatures. All fish for the short storage period were stored in a commercial ice making plant. The long storage was carried out in the ice storage room of the plant.

Methods for testing quality. Total volatile bases were determined according to Conway's microdiffusion method *(1)* and histamine in the flesh was determined by the chemical method presented by Kadota and Inoue *(3)*. The determination of volatile bases was made on a trichloracetic acid extract which was prepared by blending a 16 g. sample of flesh with 100 cc. of distilled water, followed by the addition of 50 cc. of 7% trichloracetic acid solution. The resulting solution was then filtered. The determination of histamine was made on the neutralized filtrate. Samples of flesh for the determinations were taken from comminuted flesh excised from 20 fishes. Duplicate determinations on the filtrate were always made. Organoleptic examinations were also carried out.

RESULTS

Storage at 15-20° C. Values for the total volatile basic nitrogen and histamine hydrochloride are presented in Tables 2 and 3. Organoleptic observations are shown in Table 5. By plotting the data in Tables 2 and 3 into the most probable spoilage curves the incipient spoilage time can be estimated approximately by the time-period when a sharp increase in the concentration of each compound took place. The values for the induction period show the relative effectiveness of treatments and are given in the bottom two lines of Tables 2 and 3. Besides the induction period the slope of the curves may also be taken as a measure of the effectiveness, but the number of the determinations in the present study were not sufficient to determine a probable value for the slope of the curves.

TABLE 4

Change in total volatile basic nitrogen content (expressed as mg.-%) during storage at −1–2° C.

Days of storage	Experimental group						
	2	4	7	9	12	15	17
0	14.0	14.0	15.0	15.0	15.0	14.0	14.0
2	14.6	14.8	15.8	15.2	16.2	.....	.....
5	15.8	15.0	16.0	.....	16.6	14.4	14.8
9	15.8	15.0	16.6	15.4	17.0	16.2	15.6
11	20.3	.....	18.4	20.0	20.3	20.3	21.5
14[1]	17.3	18.5	21.0	22.5	21.4	23.5	49.3
18[2]	33.8	38.3	35.8	49.3	50.0	44.0	75.8

[1] The temperature of the storage room rose from −1–2° C. to 2–8° C.
[2] No ice remained.

Storage at 1-2° C. Extracts of the fish were prepared as above and the determinations were carried out in the laboratory of the Fishery Experiment Station at Ushibuka. In the case of the determination of histamine in the long storage series the extracts were shipped to our laboratory for analysis. However, due to inclement weather and delay in arrival the histamine in the extracts had deteriorated previous to analysis. For this reason histamine values for the long storage series are not presented.

Table 4 presents the data of the total volatile basic nitrogen and Table 6 presents the organoleptic observations for the low temperature storage series.

DISCUSSION

A comparison of the data given in Tables 2, 3, 4, 5 and 6 indicates that both objective tests are in fairly good accord with the organoleptic tests.

The effectiveness of the storage in the Aureomycin solution clearly can be seen on comparing group 3 or 8 in Tables 2 and 3 with group 16 in Tables 2 and 3, showing 40-80% prolongation of storage life of the control group. Data obtained from groups which were held without ice after landing showed an effective result except for group 5. Apparently the spoilage in these groups without ice proceeded rather fast so that they did not show consistent results similar to those held in ice.

TABLE 2

Change in total volatile basic nitrogen content (expressed as mg.-%) during storage at 15–20° C.

Hours after being caught	Experimental group												
	1	3	5	6	8	10	11	13	14	16	18	19	20
8	.....	.....	15.5	.....	.....	15.0	.....	16.1	.....	.....	.....	.....	16.5
32	16.0	14.2	20.0	18.0	15.0	19.2	.....	22.2	16.2	16.6	16.8	22.2	19.0
58[1]	17.4	15.8	27.0	15.6	17.8	21.8	17.2	25.8	16.6	20.4	18.0	23.6	22.6
82	16.8	18.8	28.6	19.2	19.2	23.2	20.6	25.0	18.6	23.0	22.0	27.4	26.0
106	24.6	24.4	37.6	23.4	26.6	25.4	25.6	29.4	23.0	47.4	31.8	40.2	43.4
132	25.8	37.8	47.5	27.0	33.0	36.4	31.2	44.2	28.6	94.0	67.9	59.0	70.0
157	35.6	46.0	94.2	41.2	45.8	57.8	46.2	67.6	37.2	.....	94.4	88.0	.....
179	58.0	71.3	.....	58.1	63.5	61.8	94.4	.....	64.1	.....	.....	.....	.....
Hrs. when spoiled (30 mg.-%)	145	120	95	140	120	120	120	105	140	88	100	92	88
Relative effectiveness	1.65	1.36	1.08	1.59	1.36	1.36	1.36	1.19	1.59	1.00	1.14	1.05	1.00

[1] No ice remained.

TABLE 3

Change in histamine content (expressed as mg.-% histamine HCl) during storage at 15–20° C.

Hours after being caught	Experimental group												
	1	3	5	6	8	10	11	13	14	16	18	19	20
8	.....	.....	0	.....	.....	0	.....	0	.....	.....	.....	.....	0
32	.....	.....	6.8	.....	.....	6.8	.....	6.8	.....	.....	.....	.....	6.8
58	6.8	10.9	17.0	10.9	10.9	10.9	.....	10.9	10.9	10.9	15.0	15.0	17.0
82	10.9	10.9	15.0	15.0	10.9	10.9	10.9	12.3	10.9	17.0	15.0	17.0	17.0
106	10.9	10.9	22.5	10.9	10.9	15.0	10.9	17.0	12.3	37.3	22.5	41.4	22.5
132	10.9	10.9	25.9	10.9	10.9	10.9	10.9	22.5	19.1	45.4	38.6	53.1	38.6
157	21.3	27.1	37.3	15.0	18.4	19.1	19.1	37.3	19.1	53.6	53.6	66.3	.....
179	25.9	41.4	.....	25.9	37.3	37.3	37.3	.....	45.4	.....	.....	.....	.....
Hrs. when spoiled (20 mg.-%)	160	145	97	167	160	160	157	120	150	85	100	82	85
Relative effectiveness	1.88	1.70	1.14	1.96	1.88	1.88	1.85	1.41	1.76	1.00	1.18	0.97	1.00

TABLE 5

The organoleptic phases of Pacific round herring[1] kept at 15–20° C.

Time in hours	Experimental group												
	1	3	5	6	8	10	11	13	14	16	18	19	20
8	Ib	Ib	Ib	Ia	Ia	Ia	Ia	Ia	Ia	Ia	Ia	Ia	Ia
32	Ib	Ib	Ib-Ic	Ib	Ib	Ib	Ib	Ib	Ib	Ib	Ib	Ib	Ib
58	Ib-Ic	Ib-Ic	Ib-Ic	Ib-Ic	Ib-Ic	Ic	Ic	Ib-Ic	Ib-Ic	Ib-Ic	Ib-Ic	Ib-Ic	Ic-IIa
82	Ic	Ic	Ic	Ic	Ic	Ic	Ic-IIa	Ic-IIa	Ic-IIa	IIb	Ic-IIa	Ic-IIa	IIb
106	Ic-IIa	Ic-IIa	IIa-IIb[2]	Ic	Ic-IIa	IIa	IIa	IIa	IIa	III-IV	IIa-IIb	IIb	III-IV
132	IIa	IIa-IIb	IIb-III[2]	IIa	IIa	IIb-III	IIb-III	IIb-III[2]	IIb	V	III	IIb-III[2]	V
157	IIb-III[2]	IIb-III[2]	IV	IIa	IIb[2]	III[2]	III[2]	III[2]	III[2]		V	V	
179	IV	IV		IIb-III[2]	V	V	V		V				

[1] The organoleptic phases herein presented are principally those for haddock according to Reay Shewan (*1*). Ia: Perfectly fresh. Still in rigor mortis. Ib: Perfectly fresh. Rigor mortis passed off. Ic. Flesh slightly softer. Eyes opalescent, lost brilliancy, and sunken. IIa: Flesh soft. Surface fading. Odor not stale. IIb: Flesh very soft. Incease in slime. Odor definitely stale. III: Flesh very soft and easily stripped from bone. Odor bad. IV: Flesh very soft. Surface slimy and most slime yellowish or greyish. Odor putrid. V: Very putrid.

[2] Odor different from putrid which implies that a different type of bacterial flora predominated during the course of spoilage.

No difference in the effectiveness of the solutions was observed between Aureomycin in the form of AM-A or Acronize-PD. There was essentially no difference whether Acronize B_1-ice or plain ice was supplied: in other words, the degree of dilution due to melted ice did not result in a lowering of the effectiveness under the conditions. A remarkable prolongation of storage life due to a supply of Acronize B_1-ice after landing can clearly be seen by comparing group 14 with group 16. The effectiveness in keeping quality obtained by simply holding in B_1-ice without any preliminary dip-treatment was nearly comparable to those in groups 1 and 6 in which a dip-treatment was also made. Using the values for total volatile bases the quality of group 14 appears to be a little better than either group 3 or 8, but no difference exists when the values for histamine are used for comparison.

Little effectiveness was observed in groups 18 and 19 where a dip treatment was made after landing. These results are contrary to those obtained in a preceding investigation. However, the results might be due to the fact that ice was not added to these solutions and the temperature was comparatively high. It will be seen, however, that an early dip treatment and a relatively long dip are essential to the prolongation of the storage life.

The data obtained in long storage at —1° to 2° C. were quite similar in pattern to those kept at 15° to 20° C. The greatest effectiveness is seen in groups 2 and 7 in which the storage treatment on the boat was followed by holding in B_1-ice after landing. It does not appear from data in Table 6 that in the group of herring stored at —1° to 2° C. there was a significant difference in organoleptic status due to the various antibiotic treatments. However, a significant difference was observed between the control and the experimental groups. Unfortunately a rise in temperature of the storage room from —1° to 2° C. up to 2° to 8° C. occurred after 14 days due to a shortage of ice in the room. The most probable prolongation of the storage life, therefore, was not obtained in this experiment. However, it was calculated that at least 5 days of prolongation resulted under the present condition as judged from values of total volatile bases determinations as well as organoleptic tests.

These results lead to the conclusion that the simplest way of extending the keeping time of herring is to hold the fish in Aureomycin-ice after landing when the fishing area is close to the landing port. It is better to store in Aureomycin solution when a relatively long time is necessary to get the fish to port. The best results regardless of how far the fishing area is from port can be obtained by a dip-treatment and storage in the cooled dipping solution on the boat, followed by storage in Aureomycin-ice after landing.

CONCLUSION

A study was made of various procedures for treatment with Aureomycin of round herring just after being caught.

A remarkable prolongation of storage life of round herring resulted from the treatment by either storage in sea water containing ice and Aureomycin (10 p.p.m.) on the boat, storage in an Aureomycin-containing ice (5 p.p.m.) after landing, or their combination.

A combination of the storage in Aureomycin-sea water and holding in Aureomycin-ice was found to prolong the storage life approximately 90% more than the control without treatment when stored at 15° to 20° C. and in case of storage at —1° to 2° C., at least 40%, i.e., a 5-day prolongation in storage life.

TABLE 6

The organoleptic phases of Pacific round herring[1] kept at —1–2° C.

Time (days)	Experimental group						
	2	4	7	9	12	15	17
0	Ib	Ib	Ia	Ia	Ia	Ia	Ia
2	Ib	Ib	Ib	Ib	Ib	Ib	Ib
5	Ic	Ic	Ic	Ic	Ic	Ic	Ic-IIa
9	IIa	IIa	IIa	IIa	IIa	IIa	IIb
11	IIb	IIb	IIb	IIb	IIb	IIb	III
14	IIb-III[2]	IIb-III[2]	IIb-III[2]	IIb-III[2]	IIb-III[2]	IIb-III[2]	IV
18	III[2]	III[2]	III[2]	III[2]	III[2]	III[2]	

[1] The codes for the organoleptic phases are the same as shown in Table 5.

[2] Odor different from putrid.

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Time-Errors in the Paired Comparison Taste Preference Test[a]

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Many people concerned with taste preference testing of foods have noted a significant over-selection of the first or second sample in a paired comparison test. Such an occurrence is a time-error. This investigation was undertaken to study some of the characteristics of the effect and if possible to find a way of eliminating it.

The phenomenon of time-errors is well established in psychophysics. As early as 1860 Fechner *(3)* found in weight estimating experiments where the standard was given first and the variable second that often there was a systematic underestimation or overestimation of the variable, usually the latter. Where two standards were compared the one received second tended to be judged heavier. This was a negative time-error, the most common form of the phenomenon.

The presence of a time-error is not restricted to experiments of weight lifting. Philip *(8)* and other investigators have found it in judgments of time intervals. Marchetti *(5)*, McClelland *(6)*, and Tresselt *(10)* found it in judgments of lines, circles, and squares; still others have found a time-error in affective judgments of odors and tastes. The phenomenon has been shown to vary with the type and range of stimuli, the time interval between stimuli, the type of judgment, the level of stimulation, the training of the subject in the experimental method, and many other conditions.

Danzfuss *(2)* found a negative error in preference judgments of chords, and Beebe-Center *(1)* generally verified this result with tones and odors, although he found a positive time-error when the interval between samples was reduced to 1½ seconds. In studies of noises and pure tones Postman *(9)* found a positive time-error when the interval was one or two seconds but it became negative when the interval was increased to four or more seconds. Kohler *(4)* reported, however, that the positive phase disappeared entirely with the continued repetition of the experiment.

Responses in a paired comparison preference test are not assigned physical values. Therefore, we cannot measure a time-error in terms of some average quantity of physical error as is done in psychophysics. We can, however, measure any over-selection of either the first or second sample, and this is a time or order error. The term time-error is somewhat misleading in connection with preference because the concepts of correctness and error are not normally associated with experimental aesthetics. This seems to be only a semantic problem. Logically and psychologically, the systematic over-selection of the first or second of two samples in a taste preference test must be closely related to the same phenomenon when the experiment is concerned with the heavier of lifted weights. The underlying neurological events could well have a similar close relationship.

From the experience in psychophysics it would seem reasonable to expect a time-error in a paired comparison preference test, and that it would be in a negative direction because of the relatively long interval between samples. The underlying cause of a negative time-error is believed in many areas of psychophysics to be that the second stimulus is reinforced by a neurological trace from the first. If this hypothesis is correct, the second of two taste stimuli should seem more intense and could therefore be less pleasant. When this did occur, it would result in an over-selection of the first sample—a positive time-error. Such has generally been the finding in paired comparison testing of food products, and it also has been found by Peryam *(7)* in hedonic scale studies.

If the test samples were very different and one was definitely preferred, it would seem reasonable to assume

[a] The experimental work for this paper was done while the author was employed by Joseph E. Seagram & Sons, Inc., Louisville, Kentucky.

that the time-error effect would be at a minimum. On the other hand, if the samples were quite similar, or, though not similar, were almost equal in preference, the time-error effect should be more pronounced.

Little progress has been reported in controlling or eliminating the error, although some investigators have found that it tends to decrease as the subject becomes more experienced. Assuming the neurological trace theory can be accepted, the time-error problem resolves to either eliminating the first to second stimulus trace or adding a similar trace to the first stimulus. Many attempts have been made to reduce interference from one sample to the next by such things as rinsing with water or peroxide, or by eating soda crackers. All of these, however, lengthen the between sample interval thus reducing the advantage of intimate comparison provided by the paired comparison design.

The logical answer, it would seem, is to add a similar trace to the first sample. For many years the Seagram laboratories used a pre-test sample before the paired comparison test but its use was discontinued as unnecessary. Such a "conditioner" sample given before the first of the two test samples should, however, add a similar trace to the first stimulus and result in the intensity appearing more nearly equal for the two test samples, thus eliminating or diminishing the effect of a time-error.

These hypotheses follow from this reasoning:

1. A time-error will be found in a paired comparison taste preference test, and it will be positive in direction.
2. It will be largest when the two test samples are identical and will decrease as the difference between samples increases.
3. A "conditioner" sample will reduce or eliminate the time-error.

EXPERIMENTAL

Materials. Whiskey was the effective flavoring material in all tests. In half of the tests the whiskey was reduced to 45° proof with demineralized water and a 4 ml. sample served. In the other tests a one-ounce glass was filled with 4 ml. of ice, 6 ml. of the test whiskey, and 19 ml. of carbonated water.

The tests were divided into 4 classes according to the degree of difference between the 2 whiskeys constituting the pair as shown by taste difference tests. The classifications were:

I. Identical samples.

II. Nearly identical samples, from different production lots although a trained taste panel failed to detect a difference by the duo-trio test.

III. Moderately different samples, 75%-80% correct responses by the duo-trio test.

IV. Very different samples—more than 80% correct responses by the duo-trio test.

Subjects. The test subjects, numbering about 120, were part of a regular laboratory preference panel. They were all experienced in sensory testing and with the paired comparison method in particular. The same group of subjects was used in all tests with the exception of those reported in Table 3.

Methods. The paired comparison method was used throughout, but there were two variations in specific procedure. In the standard method the subject was presented with two samples, their order being determined randomly with the restriction that each sample was presented first the same number of times. A 30-second interval was maintained between samples. The subject verbally indicated a preference for either "sample one" or "sample two." A "no preference" response was not permitted.

The second method was identical except that a "conditioner" sample was presented before the test proper. It was the same size as the other samples and consisted of a 50/50 mixture of the two test materials. After the "conditioner" the subject rinsed his mouth with water and waited 30 seconds before the first test sample.

Forty responses were obtained on each pair of test samples.

RESULTS AND DISCUSSION

Table 1 gives the results of the tests using the standard method. The data confirm the presence of a time-error.

TABLE 1

Time-errors in paired comparison taste preference tests

Class of samples	Number of judgments	Number preferring first sample	Percent preferring first sample	t
IV. Very different	1360	704	52.5	1.8†
III. Moderately different	2880	1550	53.8	4.1***
II. Nearly identical	960	538	56.0	3.8**
I. Identical	800	477	59.6	5.4***
All samples	6000	3269	54.5	7.1***

† Insignificant.
** Significant 1% level.
*** Significant .1% level.

That the time-error is positive is contrary to the general findings in other areas of experimental aesthetics and in psychophysics, but agrees with the results of other taste preference investigations.

A more important aspect of these data is the increase in the percent choosing the first sample of the pair as we go from Class IV samples (very different) to Class I samples (identical). The percent preferring sample one on tests of Class I materials is significantly (1% level) higher than on tests of either Class III or Class IV samples. These data indicate that the magnitude of the error was directly associated with the degree of difference between the samples of the pair. It is reasonable to suppose that the subject's impression of the difference between samples, on which he ultimately must base his preference decision, is necessarily weak when the samples are nearly alike or identical. In this situation the time-error effect is relatively strong because it is not opposed. On the other hand, when the subject can easily note the difference between samples, a slight change in apparent intensity due to order of tasting (if the neurological trace is the cause of the time-error) is relatively unimportant in the preference judgment.

This finding is particularly important because it means that the greatest constant error will be found in preference tests in which the samples are quite similar and where the highest sensitivity in the measurement device is needed. Conversely, where samples are quite different and preference trends are apt to be pronounced, the time-error is less important.

Table 3 shows the results from a paired comparison preference test on 2 brands of whiskey using a consumer panel. The 2 brands were sufficiently different to fall in the Class IV category, and the data indicate an even greater time-error than was found with a laboratory panel on similar samples. This means that the effect has

TABLE 2
Effect of a conditioner sample on time-errors

Method	Class of samples	Number of judgments	Number preferring first sample	Percent preferring first sample	t
With conditioner sample	I. Identical [1]	800	393	49.1	0.5
Without conditioner sample [2]	I. Identical [1]	800	477	59.6	5.4***

*** Significant 0.1% level.
[1] The same material was used on all tests.
[2] These data from Table 1.

TABLE 3
The effect of time-errors in paired comparison consumer preference tests of two brands of whiskey

Brand "A" as first sample			
Brand	Number preferring	Percent preferring	t
Brand A	181	56.6	2.3*
Brand B	139	43.4	
Brand "B" as first sample			
Brand	Number preferring	Percent preferring	t
Brand A	123	38.4	4.1***
Brand B	197	61.6	
Combined results (balanced order presentation)			
Brand	Number preferring	Percent preferring	t
Brand A	304	47.5	1.3**
Brand B	336	52.5	

* Significant 5% level.
** Insignificant.
*** Significant 0.1% level.

serious implications for all consumer testing, despite degree of difference or preference. It would also seem to support the contention that increased experience in a particular method reduces the time-error.

The hypothesis was made that a conditioner sample presented before the first of the pair of samples would eliminate or reduce the time-error, since such a sample would provide a frame of reference for the first sample similar to that in which the second sample is judged. Class I materials were chosen for investigation of the conditioner sample since the greatest time-error was found with these materials when using the standard method. Table 2 gives the results of this part of the study. These data, in contrast to those from the standard method, show no time-error, either negative or positive. The slight over-selection of the second sample is not significant.

If the time-error effect is caused by a trace stimulation interfering with or augmenting the second of two stimuli, a conditioner sample should have the same effect on the first sample. If the positive time-error found here was due to adaption or fatigue, the conditioner sample should make conditions more nearly equal for the two test samples. Both of these statements are assumptions and this study did not prove or disprove either, but the conditioner sample did eliminate the time-error. Therefore, it must be concluded that any time-sensory process which may have operated tended to make the first sample received more pleasant and the conditioner sample served to negate this effect.

There may be several theories that could explain a positive time-error in a preference test, including a simple psychological preference for the number one. This theory loses credence, however, since the conditioner sample did eliminate the time-error and a conditioner as such would not seem to have any effect on a psychological preference for the number one. On the other hand, nothing about this study in any way refuted the theories based on neurological traces, which have had strong support in traditional psychophysics, and it would seem reasonable to assume the same explanatory principles apply in the field of preference testing until evidence indicates otherwise.

SUMMARY

Analysis of data from paired comparison taste preference tests on whiskey revealed a significant positive time-error, i.e. a greater frequency of choice of the first sample. The magnitude of the effect was directly related to the amount of taste difference between the paired samples. The greatest time-error was found when the difference was small and the least time-error when the difference was large. A conditioner sample, similar to the paired samples, when presented before the first sample of the pair eliminated the time-error.

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Nutritive Value of Instant Nonfat Dry Milk

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In 1954 a new type of nonfat dry milk solids appeared on the retail market. This product was designated as instant nonfat milk because it could be quickly and completely reconstituted by adding the product to water and stirring with a spoon. Although instant milk was originally introduced for sale to a limited market by one company, this introduction was quickly followed by other similar products. Within a year at least three instant nonfat dry milks were distributed on a national basis and at the present time several brands are available. These products are not identical and vary in other properties but all share the property of convenient reconstitution.

The processes used for preparing instant nonfat dry milk have not been revealed in detail, but it is believed that at least two brands are prepared by reprocessing spray-dried, low-heat, nonfat dry milk. Since additional processing occurs the question arises as to whether the nutritional value of instant nonfat dry milk is similar to that of regular spray-dried nonfat dry milk. In order to answer this question vitamin determinations have been made on ten samples of each of two brands of instant nonfat dry milk. All available information indicates that both of these are reprocessed. It should also be stated that both products are of the low heat type, i.e. minimum heat treatment was given before drying in contrast to the more drastic high heat treatment given nonfat dry milk solids prepared for the bakery trade. In the high heat products it is the forewarming or preheat treatment that is most likely to damage nutritive value. Condensing, spray drying, or reprocessing are milder treatments because of lower temperatures or shorter time intervals.

For one brand of instant nonfat dry milk it was possible to compare vitamin content before and after reprocessing in a number of cases. These data seem of special interest.

The samples were analyzed on a reconstituted basis. In order to adjust accurately the final volume on reconstitution, the samples were mixed with a part of the required water, stored in a refrigerator for 16 to 24 hours to permit the foam to break, then diluted to the final volume and analyzed. An exception was made in the case of the samples for ascorbic acid analysis. Because this vitamin is so easily oxidized, the samples were reconstituted with a calculated amount of water, the foam was discarded and the samples were analyzed immediately.

All the samples used for the vitamin analysis were from commercial lots, which were offered for sale or were purchased on the retail market. The sample of first process nonfat dry milk used for the protein quality study was a composite of several lots of commercial low heat powder. The instant powder prepared from it was processed in a smaller than commercial lot but by the same method used for producing other lots of brand No. 1 instant nonfat dry milk.

THIAMINE

Thiamine was determined by a fluorometric method described by Hodson *(17)*. The data are presented in Table 1. The thiamine contents of both products fall in the normal range, i.e. they are comparable to that of fresh milk. Bulletin 119 of the National Research Council, "The Composition of Milk" *(17)*, gives 42 mmg. per 100 ml. (0.42 mg. per liter) as a representative summary value for thiamine in cow's milk. The average value found for brand No. 1 was 0.45 and for brand No. 2 was 0.41 mg. per liter on a reconstituted basis. There is no indication of thiamine loss during reprocessing.

TABLE 1
Thiamine content of nonfat dry milk solids
(Reconstituted Basis)

Brand No. 1			Brand No. 2	
Sample number	Mg. Thiamine per liter		Sample number	Mg. Thiamine per liter (instant)
	1st process (basic)	2nd process (instant)		
1	0.45	0.45	1	0.38
2	0.44	0.49	2	0.40
3	0.42	0.43	3	0.42
4	0.45	0.46	4	0.39
5	0.48	0.47	5	0.43
6	0.38	0.42	6	0.44
7	0.49	0.45	7	0.41
8	0.49	0.45	8	0.49
9	0.47	0.47	9	0.40
10	0.44	0.46	10	0.38
Average	0.45	0.45	Average	0.41

RIBOFLAVIN

Riboflavin was determined by a simplification of the method of Hodson and Norris *(16)*. The data on riboflavin for both instant products (Table 2) also fall in the range for fresh milk. The average value for reconstituted brand No. 1 instant milk was 1.57 mg. per liter and for reconstituted brand No. 2 was 1.83 mg. per liter.

TABLE 2
Riboflavin content of nonfat dry milk solids
(Reconstituted Basis)

Brand No. 1			Brand No. 2	
Sample number	Mg. Riboflavin per liter		Sample number	Mg. Riboflavin per liter (instant)
	1st process (basic)	2nd process (instant)		
1	1.63	1.53	1	1.94
2	1.64	1.58	2	1.76
3	1.61	1.64	3	1.66
4	1.71	1.66	4	1.96
5	1.42	1.59	5	1.84
6	1.73	1.76	6	1.82
7	1.66	1.68	7	1.66
8	1.47	1.49	8	1.83
9	1.31	1.29	9	2.01
10	1.49	1.49	10	1.83
Average	1.567	1.571	Average	1.831

Bulletin 119 of the National Research Council *(17)* gives 158 mmg. per 100 ml. (1.58 mg. per liter) as a representative value for the riboflavin content of cow's milk. There is no indication that destruction occurs during reprocessing, since the samples have approximately the same content before and after treatment.

NIACIN

Niacin was determined by the A.O.A.C. Microbiological Method *(1)*. *L. arabinosus* 17-5 was the assay organism. The data are summarized in Table 3. The

TABLE 3
Niacin content of nonfat dry milk solids
(Reconstituted Basis)

Brand No. 1			Brand No. 2	
Sample number	Mg. Niacin per liter		Sample number	Mg. Niacin per liter (instant)
	1st process (basic)	2nd process (instant)		
1	0.835	0.781	1	0.745
2	0.777	0.804	2	0.915
3	0.794	0.746	3	0.711
4	0.739	0.735	4	0.805
5	0.896	0.901	5	0.710
6	1.000	0.983	6	0.727
7	1.024	1.020	7	0.866
8	0.850	0.779	8	0.724
9	0.736	0.749	9	0.802
10	0.767	0.750	10	0.725
Average	0.842	0.825	Average	0.773

average value for brand No. 1 of instant nonfat dry milk was 0.825 mg. per reconstituted liter and for brand No. 2 was 0.773 mg. per reconstituted liter. These values fall in the same range and are comparable to the 85 mmg. per 100 ml. (0.85 mg. per liter) cow's milk reported in National Research Council Bulletin 119 *(17)*. If there is any loss of niacin during the reprocessing of brand No. 1 instant dry milk, it is very minor.

PANTOTHENIC ACID

Pantothenic acid was determined with a microbiological method using *L. arabinosus* 17-5 as the assay organism. The assay media was an adaptation of the A.O.A.C. niacin media. An excess of niacin was added and calcium pantothenate was omitted from the media. This method was suggested by Snell *(20)*.

In the samples studied brand No. 1 had a slightly higher average value (Table 4). Brand No. 1 instant nonfat dry milk contained 3.69 mg. per liter and brand No. 2 instant nonfat dry milk contained 2.95 mg. per liter on a reconstituted basis. No great significance should be placed in the small difference since all the values fall in the normal range for fresh milk. Bulletin 119 of the National Research Council gives a representative summary vlaue of 350 mmg. per 100 ml. (350 mg. per liter) for cow's milk with a range of 155-568 mmg. per 100 ml. (1.55-5.68 mg. per liter). Hodson *(13)* gave an average value of 3.1, 3.1, 3.6 and 3.3 mg. per liter respectively for fresh milk, for reconstituted irradiated evaporated milk, for reconstituted dry skim milk and for reconstituted dry whole milk. The range of values was 1.9 to 4.3 mg. per liter. All the samples in Table 4 are excellent sources of pantothenic acid. There is no evidence that the reprocessing of brand No. 1 decreases its pantothenic acid content.

TABLE 4
Pantothenic acid content of nonfat dry milk solids
(Reconstituted Basis)

Brand No. 1			Brand No. 2	
Sample number	Mg. Pantothenic acid [1] per liter		Sample number	Mg. Pantothenic acid [1] per liter (instant)
	1st process (basic)	2nd process (instant)		
1	3.61	3.78	1	2.75
2	3.72	3.61	2	2.85
3	3.98	3.97	3	3.41
4	3.74	3.75	4	2.45
5	3.47	3.26	5	2.93
6	3.74	3.54	6	2.79
7	3.76	3.68	7	3.31
8	3.80	3.63	8	3.45
9	3.81	3.69	9	2.82
10	3.96	4.01	10	2.64
Average	3.76	3.69	Average	2.94

[1] Expressed as free acid and not as referred to a calcium pantothenate standard such as is often done. Multiply by 1.087 to place value on a calcium pantothenate basis.

Pantothenic acid deficiency has been produced in every species subjected to a critical experiment limiting the intake of the vitamin and it is believed to be almost universally required, but the human requirement for the vitamin has not been established. There are only a few publications describing symptoms attributed to this deficiency in humans. Pantothenic acid is widely distributed in common foodstuffs so that a deficiency of this vitamin is not likely to be encountered in practical human or animal nutrition.

VITAMIN B_6

Since there is general lack of agreement when vitamin B_6 methods are applied to certain milk products two methods were used in the present study. The first method was the microbiological method of Stokes, Larsen, Woodward and Foster *(21)*. This method was modified by the addition of thiamine to the media as suggested by Harris *(8)*. This addition eliminates the need for destroying thiamine in the sample and creates a more sensitive and perhaps more specific method. The method of Stokes *et al. (21)* uses "pyridoxineless" mutant No. 299 of *Neurospora sitophila*, a mold, as the assay organism. The second method was the yeast method of Atkin, Schultz, Williams and Frey *(2)* which uses *Saccharomyces carlsbergensis* as the assay organism. This method was modified by addition of niacin to the media as suggested by Rabinowitz and Snell *(18)* and by the use of small erlenmeyer flasks in place of tubes for growing the yeast to eliminate continuous shaking.

Since the data on brand No. 1 instant dry milk had been already collected by the two methods for another purpose, a direct comparison between basic process and instant milk was not made. The vitamin B_6 data are compiled in Table 5. When one considers the variability of the data, it is apparent that the vitamin B_6 content of both products is similar. These data are also comparable to the average values for fresh milk, 0.33 mg. per liter and 0.35 mg. per liter found respectively by the *Saccharomyces carlsbergensis* and *Neurospora sitophila* No. 299 methods as modified. These vitamin B_6 data are lower than many reported in the past. In part this is due to the fact the values reported here are in terms

TABLE 5
Vitamin B_6 content of nonfat dry milk solids
(Reconstituted Basis)

Brand No. 1			Brand No. 2		
Sample number	Mg. Vitamin B_6 per liter—instant		Sample number	Mg. Vitamin B_6 per liter—instant	
	Saccharomyces carlsbergensis 4228 method	N.S. 299 "pyridoxine-less" method		*Saccharomyces carlsbergensis* 4228 method	N.S. 299 "pyridoxine-less" method
1	0.39	0.34	1	0.32	0.31
2	0.36	0.32	2	0.32	0.29
3	0.35	0.31	3	0.31	0.28
4	0.36	0.34	4	0.32	0.33
5	0.35	0.33	5	0.41	0.38
6	0.39	0.33	6	0.37	0.36
7	0.39	0.33	7	0.36	0.32
8	0.37	0.34	8	0.32	0.31
9	0.42	0.34	9	0.25	0.27
10	0.38	0.34	10	0.36	0.30
Average	0.38	0.33	Average	0.33	0.32

of pyridoxine and not pyridoxine hydrochloride. Also the inclusion of thiamine in the mold media and niacin in the yeast media eliminates a source of stimulation from the milk and produces lower and more specific results. The assay of vitamin B_6 in milk products presents many problems and not all of them have been solved by the methods used in this study. However, the general agreement between the two methods and between the average values found on fresh milk and instant nonfat dry milk lend support to the validity of their use on fresh milk and low heat dry milk products.

The newer data reported here suggest the data reported by Hodson *(11)* are much too high. This can be accounted for by failure to destroy thiamine completely in the samples before assay but other factors may be involved. Other vitamin B_6 data on nonfat dry milk have been reported by Atkin *et al. (2)* and by Hassinen *et al. (9)*. These values are also slightly higher than those in Table 5. The data reported by Rabinowitz and Snell *(18)* for fresh milk seem to be in the best agreement with those reported here.

ASCORBIC ACID

Ascorbic acid was determined by the 2,6 dichloroindophenol dye titration method following the general procedures outlined in publications by Bessey and King *(4)*, Borsook *et al. (5)*, Barron *et al. (3)* and Sharp *(19)*. Both reduced and total ascorbic acid were determined. Dehydroascorbic acid was reduced with hydrogen sulfide before making the titration for total ascorbic acid. Probably the data for reduced ascorbic acid are the more useful, since the data are more accurate and since the dehydroascorbic acid is so labile it may be lost before consumption. However, the data indicate very little dehydroascorbic acid is present.

The data (Table 6), offer the suggestion that a little ascorbic acid may be lost during the reprocessing to instant powder. All the values are so low in relation to the amount found in strictly fresh milk and to the human requirement that any losses are of little nutritional importance. Milk fresh from the udder is a fair source of ascorbic acid, but the handling of milk quickly introduces air; this promotes oxidation and highly variable losses occur. Neither fresh market, pasteurized market, evaporated, nor dry milk can be considered dependable sources of ascorbic acid.

PROTEIN QUALITY

In the study of the protein quality of instant nonfat dry milk only one brand was tested, since the test was made before others appeared on the local market. The protein quality of nonfat dry milk solids has been studied many times, Fairbanks and Mitchell *(7)*, Cook *et al. (6)*, Henry and Kon *(10)*, and Hodson and Krueger *(14, 15)*. Although there is little doubt that excessive heat treatments during processing or prolonged storage under conditions of high humidity or temperature detract from protein nutritive value, it is not likely that the conditions used at present for the processing and storage of low heat nonfat dry milk solids are such as to cause damage. But specific data were not available either on the spray drying of the milk or on the reprocessing to instant nonfat dry milk, and a brief study was therefore undertaken.

A comparison was made between the protein nutritive value of pasteurized milk from a local source, a composite sample of regular low heat powder, and the same composite after being reprocessed to an instant powder. The pasteurized milk was preserved by freezing for the six-weeks' trial in order to have a uniform source of this product. Freezing is a well-accepted method of preserving milk for protein nutritive value studies. Although this acceptance may not have been proved experimentally for all cases, no alternative or better

TABLE 6
Ascorbic acid content of nonfat dry milk solids
(Reconstituted Basis)

Brand No. 1					Brand No. 2		
Sample number	Mg. per liter				Mg. per liter—instant		
	1st process (basic)		2nd process (instant)		Sample number		
	Reduced ascorbic acid	Total ascorbic acid	Reduced ascorbic acid	Total ascorbic acid		Reduced ascorbic acid	Total ascorbic acid
1	3.97	5.43	4.81	5.43	1	4.81	4.81
2	5.23	7.11	6.28	6.28	2	3.56	4.81
3	4.39	6.27	4.18	4.39	3	3.14	4.81
4	3.12	3.96	3.96	3.75	4	3.14	4.81
5	3.75	3.75	3.12	3.53	5	3.13	3.13
6	7.29	7.29	5.20	6.87	6	2.71	3.13
7	5.20	5.82	5.20	6.45	7	2.71	3.13
8	6.87	6.45	3.53	3.75	8	3.13	4.81
9	3.53	4.74	3.12	3.12	9	3.55	3.97
10	3.53	3.53	5.20	5.00	10	3.55	3.13
Average	4.69	5.44	4.46	4.86	Average	3.34	4.05

method of preservation exists at present. The diets were fed at a 9% protein level on a dry basis and were adjusted to approximately the same fat and carbohydrate content. Ten rats per group were used. In the six-weeks' comparison the rats fed the proteins from pasteurized milk, the regular single process low heat nonfat dry milk and the instant nonfat dry milk gained an average of 78.8, 88.1 and 90.6 g., respectively; although the data indicate the pasteurized milk proteins are inferior, this is not borne out by the analysis of variance for the differences are not statistically significant. F equals 3.02 and F equals 3.35 is required for significance at the 95% level. The protein efficiency expressed as grams gain per gram protein fed was also calculated for each group. For the pasteurized milk, the regular low heat powder and the instant powder this figure was respectively 2.73, 2.89 and 2.88. An analysis of variance indicates the differences are not statistically significant. F equals 3.02 and F equals 3.35 is required for significance at the 95% level. These data indicate that neither the processing of a low heat, spray dried, nonfat dry milk nor converting it to an instant nonfat dry milk damages the protein nutritive value for rat growth.

SUMMARY

On a reconstituted basis the thiamine, riboflavin, niacin, pantothenic acid and vitamin B_6 contents of two brands of instant nonfat dry milk are essentially equal to those of fresh milk samples.

The ascorbic acid content of nonfat dry milk is low and may be slightly decreased by conversion to instant powder, but the latter loss if any is of no importance because milk in any form usually available for human consumption is not a dependable source of ascorbic acid.

The conversion of a low heat nonfat dry milk to an instant nonfat dry milk by a commercial process does not measurably change the thiamine, riboflavin, nicotinic acid, pantothenic acid or vitamin B_6 content.

The protein quality of an instant nonfat dry milk as measured by rat growth is equal to that of the regular low heat powder from which it was prepared or to that of a sample of pasteurized milk.

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TECHNICAL PROGRAM AND ABSTRACTS

Sixteenth Annual Meeting
of the
Institute of Food Technologists

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June 10 through June 14, 1956

Saint Louis, Missouri

GENERAL AND SOCIAL EVENTS

Saturday, June 9, 1956

Executive Committee Meeting
10:00 a.m. Room 6,
Sheraton-Jefferson Hotel

St. Louis Section Committee Chairmen,
Dinner Meeting
6:00 p.m. Room 7,
Sheraton-Jefferson Hotel

Editorial Board Meeting
7:30 p.m. Room 4,
Sheraton-Jefferson Hotel

Sunday, June 10, 1956

National Council Meeting
10:00 a.m. Room 9,
Sheraton-Jefferson Hotel

Registration
10:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

Exhibits
1:00 p.m. Official Opening, Mezzanine,
Sheraton-Jefferson Hotel

Ladies' Get-Acquainted Tea
3:00 p.m. Crystal Room,
Sheraton-Jefferson Hotel

Press Conference
4:00 p.m. Room 5,
Sheraton-Jefferson Hotel

Social Hour
8:00 p.m. Gold Room,
Sheraton-Jefferson Hotel

Monday, June 11, 1956

Section Officers' Breakfast
7:30 a.m. Room 1,
Sheraton-Jefferson Hotel

Registration
8:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

General Opening Session
9:30 a.m. Gold Room,
Sheraton-Jefferson Hotel

Ladies' Tour—Anheuser-Busch, Grant's Farm
9:30 a.m. Start from Sheraton-Jefferson Hotel

Visit the Exhibits
11:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

Awards Luncheon
12:30 p.m. Gold Room,
Sheraton-Jefferson Hotel

Technical Program
2:00 p.m. Four Sessions
Gold Room, Sheraton-Jefferson Hotel
Crystal Room, Sheraton-Jefferson Hotel
Foyer 2, Statler
Ballroom, Statler

Musical Comedy Under the Stars:
"Annie Get Your Gun"
7:45 p.m. Departure from
Sheraton-Jefferson Hotel

Tuesday, June 12, 1956

Canadian Group IFT Breakfast
7:30 a.m. Room 9,
Sheraton-Jefferson Hotel

M. I. T. Alumni Breakfast
7:30 a.m. Room 7,
Sheraton-Jefferson Hotel

University of Illinois Breakfast
7:30 a.m. Room 8,
Sheraton-Jefferson Hotel

Registration
8:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

Technical Program
9:00 a.m. Five Sessions
Gold Room, Sheraton-Jefferson Hotel
Crystal Room, Sheraton-Jefferson Hotel
Room 1, Sheraton-Jefferson Hotel
Foyer 2, Statler
Ballroom, Statler

Ladies' Tour
9:30 a.m. Departure from the Sheraton-Jefferson
Fouke Fur Company, Alaskan Seal processing plant
Luncheon at the Art Museum
St. Louis Zoo

Visit the Exhibits
11:00 a.m.

University of Massachusetts Alumni Luncheon
12:30 p.m. Room 9,
Sheraton-Jefferson Hotel

Ohio State University Alumni Luncheon
12:30 p.m. Room 8,
Sheraton-Jefferson Hotel

Technical Program
2:00 p.m. Five Sessions (as in the morning)

Phi Tau Sigma Honorary Society Meeting
5:00 p.m. Room 1,
Sheraton-Jefferson Hotel

Appert Award Banquet
7:00 p.m. Gold Room,
Sheraton-Jefferson Hotel

Wednesday, June 13, 1956

Registration
8:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

Technical Program
9:00 a.m. Five Sessions
Gold Room, Sheraton-Jefferson Hotel
Crystal Room, Sheraton-Jefferson Hotel
Room 1, Sheraton-Jefferson Hotel
Foyer 2, Statler
Ballroom, Statler

Ladies' Tour
9:30 a.m. Historic St. Louis
Departure from
Sheraton-Jefferson Hotel
12:30 p.m. Luncheon at Missouri Athletic Club (Ladies)

Visit the Exhibits
11:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

Installation Luncheon
12:30 p.m. Gold Room,
Sheraton-Jefferson Hotel

Technical Program
2:00 p.m. Four Sessions
Gold Room, Sheraton-Jefferson Hotel
Crystal Room, Sheraton-Jefferson Hotel
Foyer 2, Statler
Ballroom, Statler

Ladies' Tea
3:30 p.m. Dream Kitchens of
Laclede Gas Co.

Mississippi River Boat Ride
8:30 p.m. Assemble at "Admiral" Dock,
foot of Washington Street
9:00 p.m. Sailing time

Thursday, June 14, 1956

Registration
8:00 a.m. Mezzanine,
Sheraton-Jefferson Hotel

Plant Tours
8:00 a.m. Mrs. Tucker's Foods,
Jacksonville, Illinois
Departure, Sheraton-Jefferson
8:45 a.m. Pevely Dairy Company,
1st Section
9:30 a.m. Aluminum Corporation of
America, 1st Section
Ore Research Laboratories
9:30 a.m. Continental Can Company,
Metal Containers Div.
10:00 a.m. Freund Baking Company
10:00 a.m. V. Viviano & Bros. Macaroni
Mfg. Co., 1st Section
10:15 a.m. St. Louis *Post-Dispatch*,
1st Section
Radio Station KSD
Television Station KSD-TV
1:15 p.m. St. Louis *Post-Dispatch*,
2nd Section
Radio Station KSD
Television Station KSD-TV
1:30 p.m. V. Viviano & Bros. Macaroni
Mfg. Co., 2nd Section
1:30 p.m. Continental Can Company,
Fibre Drum Division
1:45 p.m. Pevely Dairy Company,
2nd Section
2:00 p.m. Aluminum Corporation of
America, 2nd Section
Ore Research Laboratories

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LADIES' PROGRAM

Tickets Required for All Functions

To our lady guests St. Louis offers a particularly cordial welcome. A variety of activities and entertainment have been arranged for your enjoyment. Or, if you prefer independent sight-seeing or shopping, our committee will help you arrange the trips. Our general Hospitality Committee will have maps and information about interesting local attractions.

All scheduled events will be controlled by the use of tickets which may be obtained at the Registration Desk, not later than the day prior to the event. All buses leave from the 12th Street entrance of the Sheraton-Jefferson.

Sunday, June 10

3-6 p.m. All ladies are invited to a Get-Acquainted Tea in the Crystal Room, Sheraton-Jefferson Hotel. Much of your pleasure depends on getting acquainted, so please come! Meet your friends and your hostesses who will look after your comforts during the annual meeting.

8:00 p.m. Social Hour. Refreshments and entertainment for all registrants. Gold Room, Sheraton-Jefferson Hotel.

Monday, June 11

9:30 a.m. We shall visit the Anheuser-Busch Brewery where we shall be shown every phase of how Budweiser is brewed, packaged and shipped. A buffet luncheon will be provided for us in ample time to board our bus for Grant's Farm, the famous home of General Ulysses S. Grant. Here, we are taken on a miniature railroad over the 281 acres of this fabulous estate, where deer, antelope, mountain goats and bison roam the area. Our visit will include Grant's cabin, the Carriage Museum, Miniature Zoo, the famous Clydesdale horses and the Bauernhof, where refreshments will be served before returning to the hotel to freshen up for an evening at the opera.

7:45 p.m. "Annie Get Your Gun." The St. Louis Municipal Opera is world famous for its light opera and musical comedy presentations in the beautiful amphitheatre in Forest Park. Many of our leading musical comedy stars made their debut here since the inception of the "opera" over twenty-five years ago. This is a *must* for visitors to St. Louis.

Tuesday, June 12

9:30 a.m. Fouke Fur Company is delighted to have us tour its plant where we shall see the only Alaskan seal processing operation in the United States. A delicious luncheon will be waiting for us in the beautiful St. Louis Art Museum in Forest Park. There, we will have time to view some of the high spots of the museum before moving on to the world-famous zoo where seats will be set aside for us to relax and enjoy the monkey show. These little fellows are probably the best-dressed monkeys in the world. They are often amused by the actions of man. We will be back at the hotel in plenty of time to "primp up" for the banquet.

7:00 p.m. Appert Award Banquet — Gold Room, Sheraton-Jefferson Hotel.

Wednesday, June 13

9:30 a.m. The downtown area and the waterfront will be our destination, with a stop at the Old Court House. Inside is a fine museum of old paintings and St. Louis memorabilia. Just a hop, skip and jump away, a group of not more than 40 persons will be shown through the Eighth District Federal Reserve Bank. "Your guns and money should be left at home as they have plenty of both."

12:30 p.m. Luncheon will be served in the St. Louis Room of the Missouri Athletic Club. In the afternoon, tours through the St. Louis *Post-Dispatch* newspaper facilities have been arranged for groups of not more than 30 at a time.

3:30 p.m. Whether you make the tours or spend the afternoon shopping, plan on joining the group and relax in the Dream Kitchens as guests of the Laclede Gas Company, just a block away from the hotel.

8:30 p.m. Moonlight and Magnolias. All the glamour and beauty of an antebellum river packet trip with the modern advantages of streamlined luxury and air-conditioned comfort on the S. S. "Admiral." This is another St. Louis exclusive. Dancing—refreshments—real pleasure!

Thursday, June 14

You are invited to join in the general plant tours. Pick out the ones you find interesting. The variety offers something for everyone.

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PLANT TOURS

Aluminum Corporation of America

Research Laboratories, East St. Louis, Illinois

The new Ore and Metals Research Laboratories are unique. Technical personnel will point out operations of particular interest and answer questions. Two sections of 30 each will be accommodated, the first leaving the 12th Street entrance of the Sheraton-Jefferson at 9:30 a. m. and returning before lunch; the second leaving the same place at 2:00 p. m. and returning at 4:30 p. m.

Continental Can Company

St. Louis, Missouri

Two different trips—the first through the Metal Containers Division at 9:30 a. m. starting time and the second through the Fibre Drum Division at 1:30 p. m. starting time—are scheduled. A maximum of 30 can be accommodated on the morning trip through the Metal Containers Division. A maximum of 50 can be accommodated on the afternoon Fibre Drum Division trip. Buses will leave from and return to the 12th Street entrance of the Sheraton-Jefferson.

Freund Baking Company

St. Louis, Missouri

One of the largest independent bakeries in the country, the Freund Baking Company represents one family's work throughout 100 years of baking in St. Louis.

The plant bakes on separate lines, buns, white bread, rye bread, cakes, yeast-leavened sweet goods, pies, yeast-leavened doughnuts, and cake doughnuts. A maximum of 50 people can be accommodated at one time. However, should a larger number of our members desire to make this trip, the Freund Baking Company has graciously agreed to offer a second trip in the afternoon.

Mrs. Tucker's Foods

Jacksonville, Illinois

An all-day tour of a modern vegetable oil products—shortenings, margarine, etc.—plant. Enroute you will pass near the confluence of the Missouri, the Mississippi and the Illinois rivers and through the rich farming and industrial areas of central Illinois.

Lunch will be provided in Jacksonville. Buses leave the 12th Street entrance of the Sheraton-Jefferson at 8:00 a. m. and return at approximately 3:00 p. m.

Pevely Dairy Company

St. Louis, Missouri

A modern dairy offering both fluid milk and cream; and ice cream processing operations. Two sections of 25 people each, one leaving the hotel at 8:45 a. m. and the second leaving at 1:45 p. m., are available.

St. Louis *Post-Dispatch*

Radio Station KSD, Television Station KSD-TV

Two groups of 30 each can be accommodated for this trip through a modern newspaper, radio and television installation. This is just across the street from the hotel. Trips will be at 10:15 a. m. and at 1:15 p. m.

V. Viviano and Brothers Macaroni Manufacturing Company

St. Louis, Missouri

In visiting the Viviano Macaroni plant, we see the impact of mechanization and automation on the ancient art of paste goods manufacture. This completely modern plant features all new automatic equipment, some of Italian manufacture, which facilitates continuous 24-hour-a-day operation. A new vacuum system throughout makes possible marked improvements in uniformity and quality of products and in sanitation. Here again the size of each group is limited, but the firm has graciously agreed to offer both morning and afternoon trips of 20 each. The morning trip will leave the Sheraton-Jefferson at 10:00 a. m. and the afternoon trip will leave at 1:30 p. m.

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SUMMARY OF THE TECHNICAL PROGRAM

Monday, June 11

9:30 a.m. General Session—Gold Room, Sheraton-Jefferson

11:00 a.m. Closing for Luncheon

2:00 p.m. General Session—Gold Room, Sheraton-Jefferson
BABCOCK-HART AWARD ACCEPTANCE ADDRESS
"Evaluation of Microbiological Standards for Foods"
DR. GAIL M. DACK

2:40 p.m. Section A—Symposium in Commemoration of the 50th Anniversary of the Food and Drug Law. Gold Room, Sheraton-Jefferson

2:40 p.m. Section B—Microbiology. Foyer 2, Statler

2:40 p.m. Section C—General Research Papers. Ballroom, Statler

2:40 p.m. Section D—Canning. Crystal Room, Sheraton-Jefferson

Tuesday, June 12

9:00 a.m. Section E—Panel Discussion on Current Status of Chemicals in Foods. Foyer 2, Statler

9:00 a.m. Section F—Canning. Crystal Room, Sheraton-Jefferson

9:00 a.m. Section G—Meat. Gold Room, Sheraton-Jefferson

9:00 a.m. Section H—Fermentation. Ballroom, Statler

9:00 a.m. Section I—Industry and Education. Room 1, Sheraton-Jefferson

2:00 p.m. Section J—Food Engineering. Foyer 2, Statler

2:00 p.m. Section K—Meat. Gold Room, Sheraton-Jefferson

2:00 p.m. Section L—Dehydration. Crystal Room, Sheraton-Jefferson

2:00 p.m. Section M—Cereals. Room 1, Sheraton-Jefferson

2:00 p.m. Section N—General Research Papers. Ballroom, Statler

Wednesday, June 13

9:00 a.m. Section O—Radiation. Gold Room, Sheraton-Jefferson

9:00 a.m. Section P—Frozen Foods. Crystal Room, Sheraton-Jefferson

9:00 a.m. Section Q—Applications of Food Research to Meet Department of Defense Requirements. Ballroom, Statler

9:00 a.m. Section R—Citrus Products. Room 1, Sheraton-Jefferson

9:00 a.m. Section S—Fruits and Vegetables. Foyer 2, Statler

2:00 p.m. General Session—Gold Room, Sheraton-Jefferson
APPERT AWARD ACCEPTANCE ADDRESS
"Food Horizons"
DR. BERNARD E. PROCTOR

2:40 p.m. Section T—Fruits and Vegetables. Foyer 2, Statler

2:40 p.m. Section U—Radiation. Gold Room, Sheraton-Jefferson

2:40 p.m. Section V—Citrus Products. Crystal Room, Sheraton-Jefferson

2:40 p.m. Section W—Sensory Testing. Ballroom, Statler

DETAILED PROGRAM

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MONDAY MORNING — JUNE 11

GENERAL SESSION
Gold Room—Sheraton-Jefferson

9:00—CALL TO ORDER

9:05—WELCOME TO ST. LOUIS
PAUL LOGUE, Chairman, St. Louis Section

9:15—ANNOUNCEMENTS
CHARLES M. HARROLD, JR., General Chairman

9:25—PRESIDENTIAL ADDRESS
L. E. CLIFCORN

10:00—HOW MANAGEMENT LOOKS AT INDUSTRIAL RESEARCH
C. N. KIMBALL, President, Midwest Research Institute, Kansas City, Mo.

10:30—PROPOSED LEGISLATION PERTAINING TO CHEMICALS IN FOODS
THE HONORABLE A. L. MILLER, M.D., Member of Congress, Fourth District, Nebraska

11:00—ADJOURNMENT

MONDAY AFTERNOON — JUNE 11

Section A—Gold Room, Sheraton-Jefferson

2:40—SYMPOSIUM IN COMMEMORATION OF THE 50TH ANNIVERSARY OF THE FOOD AND DRUG LAW

Moderator: F. N. PETERS, Vice President, Quaker Oats Co., Chicago, Ill.

GEORGE P. LARRICK, Commissioner, United States Food and Drug Administration

A. L. MILLER, M.D., Member of Congress, Fourth District, Nebraska

EUGENE H. HOLEMAN, Superintendent of Foods and Drugs, State Department of Agriculture, Nashville, Tenn.

FRANK L. GUNDERSON, Consultant, Washington, D. C.

HENRY A. LEPPER, Past President, Association of Official Agricultural Chemists

MONDAY AFTERNOON — JUNE 11

Section B—Foyer 2, Statler

Microbiology

Chairman: C. R. STUMBO

2:40— 1. Thermal Resistance of Putrefactive Anaerobe No. 3679 Spores in Vegetables in the Temperature Range of 270° to 290° F.
W. B. ESSELEN and I. J. PFLUG, University of Massachusetts, Amherst, Mass.

3:00— 2. The Effect of Sorbic Acid on the Storage Life of Fresh Picked Meat from the Blue Crab *(Callinectes sapidus)*

MELVIN A. BENARDE, Seafood Processing Laboratory, University of Maryland, Crisfield, Md.

3:15— 3. Spore Resistance Values and Their Application in Food Processing

J. L. SECRIST and C. R. STUMBO, Food Research Dept., H. J. Heinz Co., Pittsburgh 30, Pa.

3:40— 4. The Resistance of Bacterial Spores to Superheated Steam

CHARLES P. COLLIER and CHARLES T. TOWNSEND, National Canners Association, Western Research Laboratory, and University of California Laboratory for Research in the Canning Industry, George Williams Hooper Foundation for Medical Research, Berkeley, Calif.

MONDAY AFTERNOON — JUNE 11

Section C—Ballroom, Statler

General

Chairman: D. E. BRADY

2:40— 5. Chemical Aspects of Pectin Gel Darkening

MAYNARD A. STEINBERG, Doughnut Corp. of America, 45 W. 36th St., New York, N. Y., GIDEON E. LIVINGSTON, and CARL R. FELLERS, University of Massachusetts, Amherst, Mass.

3:00— 6. Feeding Studies on Vitamin and Mineral Fortified Whole Milk

LESTER J. TEPLY, ROBERT F. PRIER, and HENRY T. SCOTT, Wisconsin Alumni Research Foundation, 506 N. Walnut St., Madison, Wis.

3:25— 7. Inspection Frequencies and Sample Numbers for Raw Materials Procured for Food Processing

AMIHUD KRAMER, University of Maryland, College Park, Md.

3:50— 8. A Re-evaluation of the Vitamin A Activity of Carotene

HENRY M. ESPOY, Barnett Laboratories, Inc., 6256 Cherry Ave., Long Beach 5, Calif.

4:10— 9. Determination of Milk Serum Protein by Direct Nesslerization

W. K. STONE and ALYCE H. HOLMES, Virginia Agricultural Experiment Station, Blacksburg, Va.

4:30— 10. Effect of Shell Treatment on the Interior Quality and Flavor of Oiled and Thermostabilized Eggs

JEANNETTE SULLIVAN and FRANCES CARLIN, Iowa State College, Ames, Iowa

4:50— 11. A Staining Method for Identifying Fly Eggs and Maggots in Food Products

M. L. FIELDS, G. R. AMMERMAN, and N. W. DESROSIER, Agricultural Experiment Station, Purdue University, Lafayette, Ind.

MONDAY AFTERNOON — JUNE 11

Section D—Crystal Room, Sheraton-Jefferson

Canning

Chairman: GEORGE W. BEACH

2:40— 12. Effects of Packing Procedure on Container Performance in Canned Applesauce

G. G. KOHN and J. E. FIX, American Can Co., Research and Technical Dept., 360 Elizabeth Ave., Newark, N. J.

3:00— 13. Effect of Additives and Blanching on the Quality of Processed Whole Kernel Corn

R. C. WILEY, University of Maryland, College Park, Md.

3:20— 14. Factors Influencing the Sporadic Development of Discoloration in Canned Wet Pack Shrimp

R. G. LANDGRAF, Continental Can Co., Inc., Metal Div., Research and Development Dept., 4645 W. Grand Ave., Chicago 39, Ill.

3:40— 15. Quality Retention in Baby Foods Processed by High Temperature-Short Time Methods

GIDEON E. LIVINGSTON and WILLIAM B. ESSELEN, University of Massachusetts, Amherst, Mass.

4:00— 16. Thermal Destruction Rates of Thiamine in Pureed Meats and Vegetables

E. FELICIOTTI and W. B. ESSELEN, University of Massachusetts, Amherst, Mass.

4:20— 17. Flat Sour Spoilage of Tomato Juice and Its Control with Subtilin

E. WHEATON, J. D. BURROUGHS, and G. L. HAYS, American Can Co., Research Division, Barrington, Ill.

TUESDAY MORNING — JUNE 12

Section E—Foyer 2, Statler

9:00—PANEL DISCUSSION ON CURRENT STATUS OF CHEMICALS IN FOODS

Moderator: B. L. OSER

IFT Committee on Chemicals in Foods

H. C. SPENCER, *Chairman*
C. N. FREY
F. L. GUNDERSON
D. B. HAND
L. F. HAYHURST
H. K. MURER
B. L. OSER
F. N. PETERS

TUESDAY MORNING — JUNE 12

Section F—Crystal Room, Sheraton-Jefferson

Canning

Chairman: GEORGE W. BEACH

9:00— 18. Storage Stability of Concentrated Tomato Juice

R. J. McCOLLOCH, R. G. RICE, and J. C. UNDERWOOD, Fruit and Vegetable Chemistry Laboratory, Western Utilization Research Branch, U. S. Dept. of Agriculture, Pasadena, Calif.

9:20— 19. Characterization of Pectin Changes in Freestone and Clingstone Peaches During Ripening and Processing

H. L. POSTLMAYR, B. S. LUH, and S. J. LEONARD, University of California, Davis, Calif.

9:45— 20. The Effect of Sirup Composition on Canned Clingstone Peaches

M. A. JOSLYN, S. LEONARD, E. HINREINER, University of California, Berkeley and Davis, Calif., and B. FILICE, Filice and Perelli Canning Co., Richmond, Calif.

10:10— 21. The Biological Evaluation of Thermal Processes

C. F. SCHMIDT and J. H. BOCK, Continental Can Co., Inc., Metal Division, Research and Development Dept., 4645 W. Grand Ave., Chicago 39, Ill.

10:35— 22. Dried Prune Products — Some Factors Influencing Their Corrosivity

J. C. CONNEL, R. D. McKIRAHAN, and A. R. WILLEY, American Can Co., San Francisco, Calif.

10:55— 23. Summarizing Remarks

TUESDAY MORNING — JUNE 12

Section G—Gold Room, Sheraton-Jefferson

Meat

Chairman: W. M. URBAIN

9:00— 24. A Chemical Study of the Volatile Nitrogen and Volatile Sulfur Fractions of Chicken

E. L. PIPPEN, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

9:20— 25. Effect of Antibiotic Solutions on the Microbial Flora of Dressed Poultry

JOHN C. AYRES, H. W. WALKER, A. W. KING and MARY JEANNE FANELLI, Iowa State College, Ames, Iowa

9:45— 26. Smoking Turkeys

H. R. MALCOM, J. G. WOODROOF, and S. R. CECIL, Georgia Experiment Station, Experiment, Ga.

10:05— 27. The Effect of Temperature of Heating and Post Mortem Age on the Water Holding Capacity and Shrinkage of Meat

EUGEN WIERBICKI and F. E. DEATHERAGE, The Ohio State University, Columbus 10, Ohio

10:25— 28. The Action of Phosphates on Sausage Products. I. Factors Affecting the Water Retention of Phosphate-Treated Meat

CLIFTON E. SWIFT and REX ELLIS, Eastern Utilization Research Branch, U. S. Dept. of Agriculture, Beltsville, Md.

10:50— 29. Effect of Controlling Environmental Conditions During Beef Aging

R. B. SLEETH, R. L. HENRICKSON, and D. E. BRADY, Missouri Agricultural Experiment Station, Columbia, Mo.

TUESDAY MORNING — JUNE 12

Section H—Ballroom, Statler

Fermentation

Chairman: ROBERT F. LIGHT

9:00— 30. Automatic Pilot Plant Control in the Development of Microorganisms

GEORGE J. FULD and CECIL G. DUNN, Massachusetts Institute of Technology, Cambridge 39, Mass.

9:30— 31. Fungi Associated with the Softening of Olives and Cucumbers in Storage Brines

GEORGES BALATSOURAS and REESE H. VAUGHN, University of California, Davis, Calif.

9:50— 32. Lindane Residue in Cucumber Fermentation

MELVIN R. JOHNSTON, University of Missouri, Columbia, Mo.

10:15— 33. Influence of Plastic Vat Covers on the Fermentation of Cucumbers

NEIL FINLEY and MELVIN R. JOHNSTON, University of Missouri, Columbia, Mo.

10:40— 34. Statistical Estimation of the First Law of Thermodynamics as Applied to the Fermentation Process for Soda Crackers

JAROSLAV TUZAR, Salerno-Megowen Biscuit Co., 4500 West Division St., Chicago 51, Ill.

11:00— 35. Effect of Cucumber Holding Time and Temperature on the Quality of Pasteurized Fresh Whole Pickles

J. A. COOK, I. J. PFLUG, and S. K. RIES, Michigan State University, East Lansing, Mich.

TUESDAY MORNING — JUNE 12

Section I—Room 1, Sheraton-Jefferson

9:00—INDUSTRY AND EDUCATION

Moderator: W. A. MACLINN, Chairman, Committee on Education

Where Do Food Technologists Go and How Much Do They Make?

R. E. MORSE, Stange Co., Chicago, Ill. (Present address: Food Technology Dept., Rutgers University, New Brunswick, N. J.)

Who Is Teaching Whom?

W. A. MACLINN, Rutgers University, New Brunswick, N. J.

Why Can't You Find a Young Food Technologist?

R. E. WALTERS, Vice-President, General Foods Corporation, White Plains, N. Y.

What Can Be Done to Attract Young People to the Food Industry?

F. K. LAWLER, Editor, *Food Engineering*, McGraw-Hill Publishing Company, New York, N. Y.

Open Discussion

TUESDAY AFTERNOON — JUNE 12

Section J—Foyer 2, Statler

Food Engineering

Chairman: I. J. HUTCHINGS

2:00— 36. Pictorial Instrumentation
L. M. RICHARDSON and W. S. YOUNG, The Foxboro Co., Foxboro, Mass.

2:20— 37. The Plastometer—A New Development in Continuous Recording and Controlling Consistometers
DAVE EOLKIN, Gerber Products Co., 9401 San Leandro St., Oakland 3, Calif.

2:45— 38. An Automatic Machine for the Continuous Mixing of Solids and Liquids to the Right Quantity and Correct Viscosity; Its Application in the Breading of Frozen Sea Food Products
R. A. MINARD, Brookfield Engineering Laboratories, Inc., 240 Cushing St., Stoughton, Mass.

3:10— 39. Direct Steam Injection for High Temperature Short Time Sterilization of Whole Kernel Corn
J. L. VETTER, A. I. NELSON and M. P. STEINBERG, University of Illinois, Urbana, Ill.

3:35— 40. Effect of Continuous Steam Injection of Tomato Juice on Film Deposition During Subsequent Concentration
A. I. NELSON, M. P. STEINBERG, J. N. McGILL, and J. L. VETTER, University of Illinois, Urbana, Ill.

4:00— 41. Measurement and Control of the More Difficult Process Variables
WM. J. SCARLETT, Industrial Division, Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Philadelphia 44, Pa.

4:25— 42. A Practical Look at Automation for the Food Plant
KARL W. MOSELEY, W. M. Sprinkman Corp., 4975 No. Santa Monica Blvd., Milwaukee 17, Wis.

TUESDAY AFTERNOON — JUNE 12

Section K—Gold Room, Sheraton-Jefferson

Meat

Chairman: W. M. URBAIN

2:00— 43. Effects of Chlortetracycline and Oxytetracycline Hydrochlorides on the Carcass Characteristics of Market Pigs
R. P. SOULE, JR., J. L. HALL, D. L. HARRISON, D. L. MACKINTOSH, D. RICHARDSON, Kansas State College, Manhattan, Kan.

2:25— 44. Chemical and Physical Changes in Isolated Beef Muscle Tenderized by Infusion with Sodium Chloride
BALWANT RAI SURI and H. W. SCHULTZ, Oregon State College, Corvallis, Ore.

2:50— 45. Inhibition of Hematin-Catalyzed Oxidative Fat Rancidity
A. L. TAPPEL and Y. T. LEW, University of California, Davis, Calif.

3:10— 46. Effect of Some Biologically Important Compounds on Rancidity and Discoloration in Cured Meat
GEORGE G. KELLEY and BETTY M. WATTS, Florida State University, Tallahassee, Fla.

3:25— 47. Sodium Ascorbate in Stabilizing Cured Meat Color
R. L. HENRICKSON, D. E. BRADY, R. B. SLEETH, Missouri Agricultural Experiment Station, Columbia, Mo.

3:45— 48. Effect of Storage Conditions on Loss of Color and Free Sulfhydryl Groups in Cured Meat
ANNE MARIE ERDMAN and BETTY M. WATTS, Florida State University, Tallahassee, Fla.

4:00— 49. The Effect of Reducing Microorganisms on The Rate of Color Development in Cured Meat
GURUDUTT P. KALLE, ARTHUR W. ANDERSON, and H. W. SCHULTZ, Oregon State College, Corvallis, Ore.

4:25— 50. Use of Organic Reductants in the Canning of Luncheon Meat
PAUL W. HARDY, J. S. BLAIR, and G. J. KRUEGER, American Can Co., Barrington, Ill.

4:45— 51. Analysis of Antioxidants in Edible Fats —An Informal Review
J. H. MAHON, Food and Drug Directorate, Dept. of National Health and Welfare, Ottawa, Ontario

TUESDAY AFTERNOON — JUNE 12

Section L—Crystal Room, Sheraton-Jefferson

Dehydration

Chairman: JOHN H. NAIR

2:00— 52. A Continuous Process for Dehydrating Fruit Juices
VICTOR A. TURKOT, RODERICK K. ESKEW, and NICHOLAS C. ACETO, Eastern Regional Research Laboratory, U. S. Dept. of Agriculture, Philadelphia 18, Pa.

2:25— 53. Low-Moisture, Red Sour Pitted Cherries
M. J. POWERS, N. J. DOWNES, D. W. SANSHUCK, and L. H. WALKER, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

2:40— 54. The Storage Stability of Freeze-Dried Peaches
C. O. CHICHESTER, University of California, Davis, Calif.

3:00— 55. Advances in the Dehydration of Mashed Potatoes by the Flake Process
JAMES CORDING, JR., MILES J. WILLARD, JR., RODERICK K. ESKEW, and JOHN F. SULLIVAN, Eastern Regional Research Laboratory, U. S. Dept. of Agriculture, Philadelphia 18, Pa.

3:30— **56.** Preparation and Evaluation of Precooked, Dehydrated Bean Products

CHARLES FELDBERG, Lt., QmC., H. W. FRITZSCHE, and JOSEPH R. WAGNER, Qm. Food and Container Institute for the Armed Forces, 1819 W. Pershing Road, Chicago 9, Ill.

3:50— **57.** The Effect of Breaking the Skin on the Cross-Circulation Drying of Green Peas

J. C. MOYER, W. B. ROBINSON, H. R. PALLESEN, and D. B. HAND, New York State Agr. Experiment Station, Geneva, N.Y.

4:15— **58.** Preparation, Preservation, and Quality of Deep Fat Fried Products of Certain Fruits and Vegetables

D. K. SALUNKHE, Utah State Agricultural College, Logan, Utah

4:35— **59.** Some Recent Work on Dehydration in the United Kingdom

E. J. ROLFE and E. G. B. GOODING, Ministry of Agriculture, Fisheries and Food Research Establishment, Aberdeen, Scotland (To be presented by Mr. S. W. F. Hanson, the British Joint Service Mission)

TUESDAY AFTERNOON — JUNE 12

Section M—Room 1, Sheraton-Jefferson

Cereals

Chairman: ROBERT A. LARSEN

2:00— **60.** Integrated Quality Control

WILLIAM W. PROUTY, American Stores Co., 59th St. and Upland Way, Philadelphia 31, Pa.

2:30— **61.** Effects of Temperature and Relative Humidity on Rate of Defrosting of Commercial Bread

J. W. PENCE, N. N. STANDRIDGE, and M. J. COPLEY, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

2:55— **62.** A Short Method for Structural Relaxation in Dough

I. HLYNKA, Grain Research Laboratory, Board of Grain Commissioners for Canada, Winnipeg 2, Manitoba, Canada

3:20— **63.** Developing New Wheat Varieties in North Dakota for Industrial Acceptance

R. H. HARRIS, L. D. SIBBITT, and G. M. SCOTT, North Dakota Agricultural College Experiment Station, Fargo, N. D.

3:45— **64.** Applications of the Irish Moss-Protein Reaction in Food Products

ELMER F. GLABE, PAULINE F. GOLDMAN, and PERRY W. ANDERSON, Food Technology Inc., 5903 Northwest Highway, Chicago 31, Ill.

4:05— **65.** Sesame

ELMER F. GLABE, PERRY W. ANDERSON, and ARTHUR F. HOLTORFF, Food Technology Inc., 5903 Northwest Highway, Chicago 31, Ill.

4:20— **66.** Some Observations Concerning Endosperm Proteins of Wheat

PROFESSOR K. HESS, Wolff and Company, Walsrode, Germany

4:40— **67.** Rheological Measurements of Physical Properties of Food in Research and Production

C. W. BRABENDER, Consultant, Minneapolis, Minn.

TUESDAY AFTERNOON — JUNE 12

Section N—Ballroom, Statler

Packaging and General Research Papers

Chairman: L. W. ELDER

2:00— **68.** Research in High Temperature Short Time Sterilization

O. F. ECKLUND and P. SOGNEFEST, American Can Co., Barrington, Ill.

2:15— **69.** An Apparatus Designed for the Rapid Electrochemical Estimation of Flavors in Vegetables

JOHN HARTMAN and WAYNE E. TOLLE, Cornell University, Ithaca, N. Y.

2:35— **70.** Some Observations on Red Pepper. I. Isolation and Analysis of Capsaicin

ROY E. MORSE, Rutgers University, New Brunswick, N. J., JOHN I. SUZUKI and FRED TAUSIG, Wm. J. Stange Co., Chicago 12, Ill.

2:55— **71.** Triose Compounds in Maple Sirup.

J. C. UNDERWOOD, H. G. LENTO and C. O. WILLITS, Eastern Regional Research Laboratory, 600 E. Mermaid Lane, Philadelphia 18, Pa.

3:15— **72.** On the Color of Coffee

ANGELA C. LITTLE and G. MACKINNEY, University of California, Berkeley 4, Calif.

3:35— **73.** Investigations of Deterioration in Cooked Oysters

ELIZABETH A. GARDNER and BETTY M. WATTS, Florida State University, Tallahassee, Fla.

3:50— **74.** A Simple Apparatus for Determining Gas Permeability of Flexible Packaging Films

RICHARD HENDERSON and GEORGE A. WALLACE, Olin Film Division, Olin Mathieson Chemical Corp., 275 Winchester Ave., New Haven, Conn.

4:10— **75.** Flavor Permeability in Food Packaging and Its Evaluation

M. KAREL, B. E. PROCTOR, and A. CORNELL, Massachusetts Institute of Technology, Cambridge, Mass.

4:35— **76.** "Mylar" Polyester Film in Food Packaging

HERBERT NAGEL and JOHN P. WILKINS, E. I. du Pont de Nemours & Co., Inc., Film Dept., Chestnut Run, Wilmington, Del.

WEDNESDAY MORNING — JUNE 13

Section O—Gold Room, Sheraton-Jefferson

Radiation

Chairman: BRUCE H. MORGAN

9:00— 77. The Effect of Gamma Irradiation on Cake Mixes Containing High and Low Moisture Levels

H. E. BAUMAN, HELEN BAEDER, and C. G. HARREL, Pillsbury Mills, Inc., 208 Third Ave., S. E., Minneapolis, Minn.

9:15— 78. Radiation Sterilization of Wheat in Relation to Respiration, Biochemical Changes and Bread-Making Properties

MAX MILNER, YIN-CHAO-YEN, and H. T. WARD, Kansas State College, Manhattan, Kan.

9:40— 79. The Effect of Temperature and Intermittent Radiation on the Acceptability of Meat

R. F. CAIN, E. C. BUBL, and A. W. ANDERSON, Oregon State College, Corvallis, Ore.

10:05— 80. Organoleptic Studies of Irradiated Foods

G. B. PRATT and O. F. ECKLUND, American Can Co., Barrington, Ill.

10:25— 81. Characteristics of Electron - Irradiated Meats Stored at Refrigerator Temperatures

J. F. KIRN, W. M. URBAIN, H. J. CZARNECKI, Swift & Company, U. S. Yards, Chicago 9, Ill.

10:45— 82. Survey of the Gross Effects of Irradiation on Selected Foods

REUBEN POMERANTZ, Captain, QmC., F. J. PILGRIM, BRUCE H. MORGAN, BEVERLEY LAYMAN, KENNETH R. WOOD, and NORMAN J. GUTMAN, Quartermaster Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

WEDNESDAY MORNING — JUNE 13

Section P—Crystal Room, Sheraton-Jefferson

Frozen Foods

Chairman: H. P. SCHMITT

9:00— 83. Objective Tests to Measure Adverse Changes in Stored Frozen Vegetables

W. C. DIETRICH, F. E. LINDQUIST, J. C. MIERS, G. S. BOHART, H. J. NEUMANN, and W. F. TALBURT, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

9:18— 84. Thawing Rates of Precooked Frozen Meals in Commercial Shipping Containers

MORTON M. RAYMAN, A. ANELLIS, and C. J. CICHON, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

9:36— 85. Studies on the Microbiological Quality of Precooked Frozen Meals

D. A. HUBER, H. ZABOROWSKI, and M. M. RAYMAN, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

9:54— 86. The Influence of Vining on the Development of Off-Flavor in Frozen Raw Peas

FRANK A. LEE, A. C. WAGENKNECHT, and R. J. GRAHAM, New York State Agricultural Experiment Station, Geneva, N. Y.

10:12— 87. Texture Stability of Thickened Precooked Frozen Foods as Influenced by Composition and Storage Conditions

HELEN L. HANSON, LORRAINE R. FLETCHER, and AGNES A. CAMPBELL, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

10:30— 88. Freezing Sweet Potatoes

J. G. WOODROOF and ETHYL SHELOR, Georgia Experiment Station, Experiment, Ga.

10:48— 89. Selective Freezing—A Unit Operation for the Food Industries

N. W. DESROSIER, Agricultural Experiment Station, Purdue University, Lafayette, Ind.

11:06— 90. Nutrient Composition of Frozen Fruits, Juices and Vegetables. (An informal presentation of recent observations pertinent to these frozen products.)

L. J. TEPLY, Wisconsin Alumni Research Foundation, 506 N. Walnut St., Madison 5, Wis.

WEDNESDAY MORNING — JUNE 13

Section Q—Ballroom, Statler

Applications of Food Research to Meet Department of Defense Requirements

Chairman: COLONEL JOHN D. PETERMAN

9:00— 91. Consolidating the Food Research Resources of the Department of Defense Through Intra-Service Coordination

JOHN D. PETERMAN, COLONEL, QMC, Commandant, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

9:20— 92. Key Objectives in Feeding Our Fighting Forces

ANGUS J. HEEKE, LT. COLONEL, QMC, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

9:35— 93. Nutritional Aspects of Air Force Feeding

BEATRICE FINKELSTEIN, Air Force Services Division, Air Materiel Command, Wright-Patterson Air Force Base, Ohio

9:55— 94. New Foods at Altitude

LT. COLONEL ALBERT A. TAYLOR, USAF, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio

10:15— 95. Methods to Extend Storage of Fresh Vegetables Aboard Ships of U. S. Navy

H. T. COOK, C. S. PARSONS, and L. P. McCOLLOCH, Agricultural Marketing Service, U. S. Dept. of Agriculture, Beltsville, Md.

10:35— 96. Quartermaster Subsistence Training Keeps Pace with Food Industry Advances

COLONEL R. F. HARTMAN, Commandant, QM Subsistence School, 1819 West Pershing Road, Chicago, Ill.

10:50— **97.** Impact of Radiation Preservation of Foods on Military Feeding

ROBERT RYER III, BRUCE H. MORGAN, REUBEN POMERANTZ, EARL W. TURNER, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

WEDNESDAY MORNING — JUNE 13

Section R—Room 1, Sheraton-Jefferson

Citrus Products

Chairman: C. W. DUBOIS

9:00— **98.** Time-Temperature Tolerance of Frozen Concentrated Orange Juice

R. J. McCOLLOCH, R. G. RICE, MARY BANDURSKI, and BRUNO GENTILI, Fruit and Vegetable Chemistry Laboratory, Western Utilization Research Branch, U. S. Dept. of Agriculture, 263 S. Chester Ave., Pasadena, Calif.

9:20— **99.** Cloud Stability of Frozen Superconcentrated Citrus Juices

R. J. McCOLLOCH, R. G. RICE, BRUNO GENTILI, and E. A. BEAVENS, Fruit and Vegetable Chemistry Laboratory, Western Utilization Research Branch, U. S. Dept. of Agriculture, 263 S. Chester Ave., Pasadena, Calif.

9:40—**100.** Stability of Frozen Concentrated Orange Juice. III. The Effect of Heat Treatments in the Production and Stability of High-Brix Frozen Concentrates

OWEN W. BISSETT and M. K. VELDHUIS, U. S. Citrus Products Station, Winter Haven, Fla., and R. B. GUYER and W. M. MILLER, Continental Can Co., Inc., Chicago, Ill.

10:05—**101.** The "COF" Effect in Citrus Products

J. S. BLAIR, EDITH M. GODAR, and J. R. MARSHALL, American Can Co., Research & Development Center, Barrington, Ill.

10:30—**102.** Oxidized Flavors in Frozen Citrus Concentrates

R. W. OLSEN, E. L. MOORE, F. W. WENZEL, and R. L. HUGGART, Florida Citrus Experiment Station, Lake Alfred, Fla.

10:55—**103.** Rate of Growth of Potential Spoilage Bacteria in Orange Juice

ALBERT BARRETO, JR. and F. W. WENZEL, Florida Citrus Experiment Station, Lake Alfred, Fla.

11:15—**104.** Amino Acid Changes During the Browning of Orange Juice

M. A. JOSLYN and P. McN. TOWNSLEY, University of California, Berkeley 4, Calif.

WEDNESDAY MORNING — JUNE 13

Section S—Foyer 2, Statler

Fruits and Vegetables

Chairman: D. K. TRESSLER

9:00—**105.** Quantitative Aspects of Strawberry Pigment Degradation

P. MARKAKIS, G. E. LIVINGSTON, and C. R. FELLERS, University of Massachusetts, Amherst, Mass.

9:20—**106.** The Role of Enzymes in Food Flavors

D. A. M. MACKAY, K. S. KONISBACHER, E. J. HEWITT, and T. HASSELSTROM, Evans Research and Development Corp., 250 E. 43rd St., New York 17, N. Y.

9:50—**107.** Recent Developments in Fruit and Vegetable Powder Technology

M. J. COPLEY, V. F. KAUFMAN, and C. L. RASMUSSEN, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

10:10—**108.** A Study of Commercial Juice Apples of the Pacific Northwest

A. M. NEUBERT, G. H. CARTER, and D. W. INGALSBE, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

10:25—**109.** Dehydrocanned Apples

M. J. POWERS, W. F. TALBURT, L. H. WALKER, and R. JACKSON, Western Utilization Research Branch, U. S. Dept. of Agriculture, 800 Buchanan St., Albany 10, Calif.

10:40—**110.** A Quality Control Program for the Processing of Sweet Corn

AARON KORNETSKY and AMIHUD KRAMER, University of Maryland, Dept. of Horticulture, College Park, Md.

WEDNESDAY AFTERNOON — JUNE 13

Section T—Foyer 2, Statler

Fruits and Vegetables

Chairman: D. K. TRESSLER

2:40—**111.** Problems Involved in the Pre-peeling and Packaging of Sweet Potatoes

WILLIAM A. SISTRUNK, Louisiana State University, Baton Rouge 3, La.

3:00—**112.** Paper withdrawn.

3:20—**113.** Polyphenolic Content and Enzymatic Activity in Two Varieties of Potatoes. I. Preliminary Report

WALTER L. CLARK, NELL MONDY, K. BEDROSIAN, R. A. FERRARI, and CATHERINE A. MICHON, Cornell University, Ithaca, N. Y.

3:40—**114.** Effect of 2,4,5-Trichlorophenoxyacetic Acid Spray on Organic Acids and Pectin Content of Canned Apricots

J. W. HOOS, S. J. LEONARD, and B. S. LUH, University of California, Davis, Calif.

4:00—**115.** Effects of Canning on New and Familiar Sweet Potato Varieties with Particular Emphasis on Breakdown and Firmness

E. R. McCONNELL and P. B. GOTTSCHALL, Continental Can Co., Inc., Metal Division, Research and Development Dept., 4645 W. Grand Ave., Chicago 39, Ill.

4:35—116. Relationship Between Calcium Content and Chipping Quality of Potatoes

KENG CHOCH NG, H. D. BROWN, and RAY BLACKMORE, The Ohio State University, Columbus 10, Ohio

WEDNESDAY AFTERNOON — JUNE 13

Section U—Gold Room, Sheraton-Jefferson

Radiation

Chairman: CAPTAIN REUBEN POMERANZ

2:40—117. Storage Properties of Gamma Irradiated Potatoes

L. E. BROWNELL, C. H. BURNS, and F. G. GUSTAFSON, Fission Products Laboratory, University of Michigan, Ann Arbor, Mich.

3:00—118. Detection of Free Radicals in Irradiated Food Constituents by Electron Paramagnetic Resonance

THOMAS M. SHAW and JOHN P. O'MEARA, Southwest Research Institute, 8500 Culebra Road, San Antonio 6, Texas

3:20—119. Studies on a Radio-Resistant Micrococcus

A. W. ANDERSON, H. C. NORDAN, R. F. CAIN, GORDON PARRISH, and DENNIS DUGGAN, Oregon Agricultural Experiment Station, Oregon State College, Corvallis, Ore.

3:40—120. Effects of Gamma Radiation on the Pectic Constituents of Fruits and Vegetables

F. J. McARDLE, Michigan State University, East Lansing, Mich., and J. V. NEHEMIAS, Fission Products Laboratory, University of Michigan, Ann Arbor, Mich.

4:00—121. Chemical Changes Induced by Irradiation of Beef, Pork, Chicken and Fish

A. L. TAPPEL, H. S. GRONINGER, and F. W. KNAPP, University of California, Davis, Calif.

4:20—122. The Effect of Ionizing Radiations on Carotenoid Stability in Tomatoes

A. LUKTON and G. MACKINNEY, University of California, Berkeley 4, Calif.

4:40—123. Radiation Induced Changes in the Maturation of Tomato Fruits

E. E. BURNS and N. W. DESROSIER, Agricultural Experiment Station, Purdue University, Lafayette, Ind.

WEDNESDAY AFTERNOON — JUNE 13

Section V—Crystal Room, Sheraton-Jefferson

Citrus Products

Chairman: C. W. DUBOIS

2:40—124. The Diacetyl Test as an Aid for Quality Control of Citrus Products

E. C. HILL and F. W. WENZEL, Florida Citrus Experiment Station, Lake Alfred, Fla.

3:00—125. Microorganisms of Significance in Frozen Citrus Products

REESE H. VAUGHN, University of California, Davis, Calif., D. I. MURDOCK and C. H. BROKAW, Minute Maid Corp., Plymouth, Fla.

3:25—126. Growth Characteristics of Spoilage Organisms in Orange Juice and Concentrate

J. M. BERRY, L. D. WITTER, and J. F. FOLINAZZO, Continental Can Co., Inc., Metal Division, Research and Development Dept., 4645 W. Grand Ave., Chicago 39, Ill.

3:45—127. Bacteriological Flora in Frozen and Chilled Orange Juice

C. W. KAUFMAN, M. PURKO, and R. V. HUSSONG, Kraft Foods Co., Glenview, Ill.

4:05—128. Factors to Consider Concerning the Occurrence of Coliforms in Citrus Products

ROGER PATRICK and F. W. WENZEL, Florida Citrus Experiment Station, Lake Alfred, Fla.

4:30—129. Current Refrigeration Problems of Interest to the Citrus Industry

D. C. McCOY, Consulting Engineer and Food Technologist, 7546 Normandy Lane, Dayton 9, Ohio

WEDNESDAY AFTERNOON — JUNE 13

Section W—Ballroom, Statler

Sensory Testing

Chairman: ERNEST E. LOCKHART

2:40—130. A Chemical and Flavor Study of Off-Flavor Due to Artificial Pepper

EMILY L. WICK and STANLEY E. CAIRNCROSS, Arthur D. Little, Inc., 30 Memorial Drive, Cambridge, Mass.

3:05—131. Consumer Attitudes Toward the Use of Imitation Pepper in Army Mess-Halls

FRANCIS J. PILGRIM and JOE KAMENETZKY, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

3:25—132. Evaluation of Flavor Changes Due to Pesticides—A Regional Approach

ROBERT C. WILEY, ALICE M. BRIANT, JEAN E. HENDERSON, IRVING S. FAGERSON, and ELIZABETH F. MURPHY, Maryland, New York, Pennsylvania, Massachusetts and Maine Agricultural Experiment Stations — NE 15 Regional Project

3:50—133. Discrimination Techniques in Meat Acceptance Studies

H. D. NAUMANN, V. J. RHODES, D. E. BRADY, and E. R. KIEHL, Missouri Agr. Experiment Station, University of Missouri, Columbia, Mo.

4:10—134. Development of a Scale for Grading Toughness-Tenderness in Beef

ELSIE L. RAFFENSPERGER and DAVID R. PERYAM, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

4:35—135. Consumer Survey on the Dessert Quality of Canned Apricots

ROSE MARIE VALDÉS, University of California, Davis, Calif.

4:55—136. Servicemen's Attitudes Toward Soluble Coffee

DAVID R. PERYAM and NORMAN J. GUTMAN, Qm. Food and Container Institute for the Armed Forces, 1819 West Pershing Road, Chicago 9, Ill.

ABSTRACTS

1

THERMAL RESISTANCE OF PUTREFACTIVE ANAEROBE NO. 3679 SPORES IN VEGETABLES IN THE TEMPERATURE RANGE OF 270° TO 290° F.

W. B. ESSELEN and I. J. PFLUG
Department of Food Technology
University of Massachusetts
Amherst, Massachusetts

Thermal death time tests were carried out with Putrefactive Anaerobe No. 3679 spores to observe their thermal destruction characteristics in the temperature range of 270° to 290° F. in vegetables. Data were obtained with these spores in fresh or frozen asparagus, green bean, corn, pea, spinach, and squash purées at temperatures of 270°, 275°, 280°, 285°, and 290° F. Additional data were obtained on samples of these products after having been canned in order to determine the effect of a prior heat treatment and accompanying decrease in pH value on the thermal resistance of bacterial spores. In general, the spores exhibited a lower degree of heat resistance in previously canned vegetable purées than in the fresh or frozen samples. The spore destruction times followed a semi-logarithmic destruction rate in the temperature range investigated. These observations are in agreement with previous work at temperatures above 250° F. reported by Stumbo and co-workers.

2

THE EFFECT OF SORBIC ACID ON THE STORAGE LIFE OF FRESH PICKED MEAT FROM THE BLUE CRAB (Callinectes sapidus)

MELVIN A. BENARDE
University of Maryland, Seafood Processing Laboratory
Crisfield, Maryland

In general, untreated food products obtained from the sea have short keeping time characteristics. Most products require marketing and consumption within 72 hours after landing. This is particularly true with crabmeat. In order to increase the shelf life, and thus reduce the excessive loss due to rapid bacterial decomposition, fresh picked meat from the blue crab was treated with 0.1, .05 and .025% (w/v) of sorbic acid. After dipping, these samples were packed into half-pound friction-top crabmeat cans and placed in storage at 0° C ± 2° C. Bacterial numbers and pH determinations were performed at 7-day intervals for a period of 40 days. It was found that sorbic acid at all 3 concentrations could enhance the storage life of the fresh meat. However, different organoleptic characteristics were obtained for each of these levels. The optimum concentration appeared to be .025 % by virtue of both increasing the storage life and affecting the eating quality least.

3

SPORE RESISTANCE VALUES AND THEIR APPLICATION IN FOOD PROCESSING

J. L. SECRIST and C. R. STUMBO
Food Research Department
H. J. Heinz Company
Pittsburgh 30, Pa.

Comparative thermal resistance values are presented for spores of Putrefactive Anaerobe No. 3679 in a variety of low-acid food products.

It has been observed that thermal resistance values may vary considerably among spore crops of the same parent microorganism. Difficulties arise, therefore, when attempts are made to calculate sterilizing processes. In addition, as much as 100% variation in D_r values has been observed for a single spore suspension of the test microorganism in the various low-acid food products.

A concept is offered for the adjustment and utilization of comparative D_r values for the calculation of thermal processes for foods.

4

THE RESISTANCE OF BACTERIAL SPORES TO SUPERHEATED STEAM

CHARLES P. COLLIER and CHARLES T. TOWNSEND
National Canners Association, Western Research Laboratory, and University of California Laboratory for Research in the Canning Industry, George Williams Hooper Foundation for Medical Research, San Francisco, California

Techniques are described whereby a pilot model aseptic canning system was used as a means of applying superheated steam to dried bacterial spores. By this means Thermal Death Time characteristics were determined for 3 bacterial species. These characteristics are best described for *B. stearothermophilus* (F.S. 1518) as $z = 26$, $D_{250} = 0.14$; for a strain of *B. polymyxa* as $z = 26$, $D_{250} = 0.13$; and for a *Clostridium* species (P. A. 3679) as $z = 60$, $D_{250} = 0.125$.

There was no correlation observed between resistance to superheated steam and resistance to saturated steam.

5

CHEMICAL ASPECTS OF PECTIN GEL DARKENING

MAYNARD A. STEINBERG
Doughnut Corporation of America
45 W. 45th St., New York, N. Y.
and
GIDEON E. LIVINGSTON and CARL R. FELLERS
Department of Food Technology
University of Massachusetts
Amherst, Massachusetts

The role of carbonyl compounds in the darkening of preserves and jellies was studied in "model" systems composed of citric acid–sucrose–pectin gels, citric acid–glucose, citric acid–fructose, and citric acid–galacturonic acid solutions.

Fourteen crystalline aldehyde 2,4-dinitrophenylhydrazones (DNPH) were isolated from a gel heated 300 minutes at 110° C. Their ultraviolet spectra indicated that five were saturated aldehydes; the remainder were unsaturated, three compounds being enals or dienals, four dienals, and two di- or trienals. One of the dienals was identified as 2-hydroxymethyl-5-furaldehyde (HMF). Three crystalline compounds were isolated from a citric acid–fructose solution heated 300 minutes at 110° C. One of these was identified as HMF, the other two compounds were enals or dienals. 2-Furaldehyde and n-butyraldehyde were isolated as DNPH from the volatile aldehyde fraction of a gel. 2-Furaldehyde was isolated from the volatile fraction of a citric acid–fructose solution. The largest component of the volatile aldehydes formed a yellow crystalline DNPH which melted at 209–210° C. Its identity was not established.

When added back to their "parent" systems, and heated, n-butyraldehyde, 2-furaldehyde, and HMF produced darkening above that produced in the controls, confirming that they are responsible, at least in part, for browning in these systems.

6

FEEDING STUDIES OF VITAMIN AND MINERAL FORTIFIED WHOLE MILK

LESTER J. TEPLY, ROBERT F. PRIER and HENRY T. SCOTT
Wisconsin Alumni Research Foundation
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Much is known about minimum vitamin requirements and about the effects of huge intakes of a particular vitamin. On the other hand, few studies have been made on the effects of moderate vitamin (and trace mineral) supplements over and above minimum requirements for growth and normal physiological functions. A vitamin and trace mineral fortified whole milk formula was tested in rats on 3 different diets: (1) milk plus trace minerals, (2) an average American diet, (a mixture of foods prepared as normally consumed by humans and in proportions according to Government figures for per capita consumption), and (3) a "simulated average American diet," (a dry ration made up of human food items and ordinary rat ration components). The latter diet was fortified to provide on a caloric basis at least the recommended daily dietary allowance of those nutrients for which the National Research Council has published allowances. The fortified milk formula provided the following final amounts per quart of the nutrients which were added:

4,000 I.U. vitamin A, 1 mg. thiamine, 2 mg. riboflavin, 10 mg. niacin, 10 mg. iron and 0.1 mg. iodine. Vitamin D was added to the control milk and fortified milk at 400 I.U. per quart.

On each diet the animals were divided into 3 groups: (a) control milk, (b) fortified milk, and (c) milk fortified to four times the usual levels of the added nutrients. For diets (a) and (c) the fortified milks were prepared twice weekly at the laboratory and in all cases the control and fortified milks came from the same batch of market homogenized milk. The milks were blended into basal diet (c) daily at 1 pint and 1 quart per 3000 calories. The average American diet (b) was prepared

every 2 or 3 months and the various milks were incorporated to provide the fluid milk portion of the diet. Diet (b) and basal diet (c) were stored in the frozen state. Eight male and 8 female weanling rats were started in each of the diet groups. They were raised and fed to produce 3 litters. Some of the animals from the second litters were bred to produce third generation animals. The original parent rats were maintained on diet (a) for 14 months, on diet (b) for 7 months and on diet (c) for 9 months. All animals were autopsied and tissues from representative animals were examined histopathologically.

The supplements had no marked effect on growth rates, feed efficiency, organ weights, or carcass composition. In general reproduction performance was good with a few exceptions which could not be related directly to the diet. No abnormalities were found on autopsy and the few minor deviations observed histologically were distributed among control and experimental animals.

7

INSPECTION FREQUENCIES AND SAMPLE NUMBERS FOR RAW MATERIALS PROCURED FOR FOOD PROCESSING

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Sampling procedures currently used in the inspection of raw materials are of questionable adequacy when they are not based on statistical principles. In this paper "attributes" and "variables" methods are presented by which the risk in terms of sampling error is determined and a sampling procedure selected on the basis of a known calculated risk. Certain "attributes" methods are proposed where the material may be rejected if it fails to meet specifications. "Variables" methods are proposed for those situations where the quality of the material is evaluated, and purchased on a quality grade basis. Tables and charts are presented to simplify the calculations involved. The effect of the nature of the material as well as methods of handling are discussed in relation to the selection of an optimum sampling procedure.

8

A RE-EVALUATION OF THE VITAMIN A ACTIVITY OF CAROTENE

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The relationship of the vitamin A activity of beta carotene compared to vitamin A has been the subject of numerous papers. During the past few years a number of authors have published work which tends to show that pure beta carotene has more than one-half the biological activity of vitamin A alcohol on a weight-for-weight basis. However, there is as yet no general agreement on the subject and various possibilities are suggested to account for the variation in the results.

A report is given of a number of biological assays that have been carried out at several recognized laboratories on various carotene products. The biological activity was correlated with careful physical-chemical assays. These results support the contention that only 0.40 to 0.45 microgram of beta carotene rather than 0.60 microgram is required to supply 1 USP unit of vitamin A activity.

The importance of arriving at the true relationship between the biological activity of various forms of vitamin A is made more urgent because of the increasing industrial usage of carotene and the present trend towards using only physical-chemical methods for the determination of vitamin A activity rather than biological assay procedures.

9

DETERMINATION OF MILK SERUM PROTEIN BY DIRECT NESSLERIZATION

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The milk serum proteins are affected by heating milk during processing. Heat treatment does not cause them to aggregate, to precipitate, or to combine with the caseinates; however, heating does make them precipitable in saturated sodium chloride. The extent of increase in precipitability in saturated salt solution has been widely adopted as an index of heat treatment of milk. This method was developed to determine, quantitatively, the milk serum proteins which are extractable with saturated sodium chloride.

The product under analysis was standardized to contain 8.0 g. of milk solids not fat and 92 g. of water. Forty g. of sodium chloride were added; the mixture was shaken vigorously for 40 seconds, and without further agitation was immersed in a 40° C. bath for 30 minutes. The "whey" was filtered through a Whatman No. 2 paper.

To a volume of "whey" in a 200 mm. x 25 mm. blood digestion tube, 6 volumes of water, 2 volumes of 5% $ZnSO_4$, and 1 volume of .5N NaOH were added. (For samples of a known high heat treatment at least 1 ml. of whey should be used.) The mixture was centrifuged, and the supernatant drawn off through a capillary tubing with the aid of low vacuum. The precipitate was digested with H_2SO_4, and nesslerized (Koch and McMeekin modification) in the digestion tube. At 515 mμ the colorimetric determinations were made with a Universal model 14 spectrophotometer.

10

EFFECT OF SHELL TREATMENT ON THE INTERIOR QUALITY AND FLAVOR OF OILED AND THERMOSTABILIZED EGGS

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Deterioration of flavor and interior quality of eggs while in marketing channels is a problem of economic concern. Results have been reported on thermostabilization of shell eggs in oil for 16 minutes at 130° F. However, the long time required by use of this method detracted from its practical value. Therefore, research was conducted to develop a commercially feasible treatment for shell eggs based on reducing the time and raising the temperature of the oil used in thermostabilization.

Experiments were conducted to test the effect of shell treatments (oil dipping and short time, high temperature thermostabilization in oil) on the quality of eggs. Pullet eggs obtained from the College poultry farm 18 to 24 hours after laying were oil dipped (30 seconds at 130° F.) or thermostabilized in oil (152° F. for 2 minutes or 160° F. for 1 minute). The treated eggs and untreated controls were stored at 70° F. in a constant temperature room.

In a second study, eggs from the mature hens were oiled (130° F. for 30 seconds) or thermostabilized in oil (160° F. for 1 minute). Treated and untreated controls were stored in a refrigerator at 34° F., or in a constant temperature room at 70° F., or in a room that fluctuated in temperature (65°–85° F.).

At weekly intervals, eggs were removed from storage and tested. Interior quality of the shell eggs was determined by Haugh units and by weight loss. Flavor of the eggs was determined by organoleptic evaluation of scrambled eggs.

Results indicated that treating eggs with oil at 152° F. for 2 minutes or 160° F. for 1 minute was an effective method of decreasing quality losses in shell eggs.

11

A STAINING METHOD FOR IDENTIFYING FLY EGGS AND MAGGOTS IN FOOD PRODUCTS

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The present A.O.A.C. method for identifying the fly egg and maggot contaminations of food products is tedious and gives variable results. A staining method has been developed which preferentially stains the substrate but leaves eggs and maggots unstained. Their identification and enumeration is rapidly accomplished by this means and with highly significant reproducibility of results. The application of this new method to food preservation and processing problems is demonstrated and illustrated.

12

EFFECTS OF PACKING PROCEDURE ON CONTAINER PERFORMANCE IN CANNED APPLESAUCE

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Objectionable headspace detinning and product discoloration have been encountered sporadically in canned applesauce for a

long time. In recent years, however, the extensive use of electrolytically coated tin plate has increased the industry's concern over this problem.

An investigation designed to study the causes of and remedy for this problem involved a test pack of applesauce in different types of cans packed under various conditions. Following are some of the important findings:

(1) The headspace detinning occurs in hot dipped as well as in electrolytic tin plate to about the same degree

(2) The detinned headspace tinplate area has a darker appearance and is more noticeable in the electrolytic tinplate than in the hot dipped tinplate

(3) The severe headspace detinning and product discoloration is associated with residual headspace oxygen

(4) The objectionable headspace detinning and product discoloration may be controlled by reducing the headspace to a minimum at closure or by using a method of closure which will largely remove the headspace air.

Incidental observations confirmed that the use of fully enamel lined cans results in general product darkening upon storage.

13

EFFECT OF ADDITIVES AND BLANCHING ON THE QUALITY OF PROCESSED WHOLE KERNEL CORN

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In canning and freezing whole kernel corn there is the problem of nutrient, flavor, and weight losses from the freshly-cut kernels due to extensive contact with water and brines in such operations as fluming, washing, blanching, processing, and subsequent storage. This work investigates the cumulative effect of pre-processing and processing factors on quality by a thorough analysis of the finished product.

Corns of different maturity, depth of cut, and seed configuration plus treatments such as dips in L.O.M. pectin, C.M.C., $CaCl_2$, and blanching before cutting were studied as independent variables.

Measurement of the quality attributes for both the canned and frozen corn consists of total sugars, total solids of the kernel and liquid portion, soluble solids of the liquid portion, per cent transmittance and turbidity of the liquid portion, drained weights, and flavor.

14

FACTORS INFLUENCING THE SPORADIC DEVELOPMENT OF DISCOLORATION IN CANNED WET PACK SHRIMP

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Both product and container discoloration were found to occur sporadically in various lots of canned wet pack shrimp. Studies were made to determine the effects of shrimp size, age in ice (length of time shrimp held in ice prior to canning), method of peeling, and reduction of pH with citric acid on the formation of discoloration in the canned product.

It was found that the most prevalent form of discoloration, product "graying," was dependent upon the age or condition of the shrimp prior to canning. That is, as the age of the shrimp in ice increased, both the pH and the amount of "graying" increased in the canned product. It was also noted that black iron sulfide container discoloration was more likely to occur with an elevated product pH.

15

QUALITY RETENTION IN BABY FOODS PROCESSED BY HIGH-TEMPERATURE—SHORT-TIME METHODS

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Samples of strained foods processed by the Martin Aseptic Process and by the Smith-Ball method were examined after packing and storage, and compared against conventionally retorted controls. Quality evaluation included measurement of vacuum, pH, viscosity and color, determination of vitamin B_1, C, and carotene content, and triangular taste panel appraisal. In general, products processed by the high temperature–short time methods showed better color and thiamine retention, and initially higher pH values than control samples. Color and thiamine advantages were retained over 12–18 months storage period. Flavor differences were largely marginal for most products, although in some instances, HT-ST vegetable samples were described as having a "raw" or "fresh" taste.

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THERMAL DESTRUCTION RATES OF THIAMINE IN PUREED MEATS AND VEGETABLES

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Data on the rate of thiamine destruction in aqueous and buffered solutions and in 8 food products at temperatures of 228°, 246°, 264°, 282°, and 300° F. are presented. In all cases, the rate of thermal destruction of thiamine was first order. As the pH is increased from 4.5 to 7.0 retention of thiamine progressively decreases. This decrease was most rapid above pH 6.0. The destruction of thiamine during the heating of the 8 food products at a given temperature varied in such a way as to make it possible to divide the foods into 2 groups. In one group would be placed puréed carrots, green beans, peas, and pork, all of which exhibited a slower rate of thiamine destruction. In the other group of 4 products, *i.e.*, puréed beef heart, beef liver, lamb, and spinach, the thiamine was more heat labile. The z values or slopes of the thermal destruction curves, over the temperature range studied, for all of the 8 foods, were in the range of 45° to 47° F.

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FLAT SOUR SPOILAGE OF TOMATO JUICE AND ITS CONTROL WITH SUBTILIN

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Many of the characteristics typical of flat sour spoilage of tomato juice as well as the methods which have been suggested for its control are reviewed briefly. Data are presented on the effect of flat sour spoilage on the vacuum in cans of tomato juice. The control of this spoilage caused by *B. coagulans (thermoacidurans)* in experimental packs by the use of the antibiotic subtilin is described. Subtilin at levels of 5 p.p.m. is shown to be effective in inhibiting growth of this organism. After inhibition for several months the spores apparently die because growth did not occur in inoculated packs after 12 months' storage, at which time the subtilin content was reduced to 1 p.p.m. or less.

18

STORGE STABILITY OF CONCENTRATED TOMATO JUICE

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Juice prepared from whole tomatoes was concentrated to 24% solids at evaporation temperatures of 105°, 150°, and 200° F. These concentrates and corresponding single-strength juices were stored for 6 months at temperatures of 40°, 70°, and 100° F. Other lots were held for longer periods. During storage, samples were periodically analyzed for changes in vitamin C, flavor, and visible darkening.

Results showed little or no differences in vitamin C stability, flavor, or darkening between the concentrates and juices stored at 40° and 70° F. At 100° F. only slight differences in vitamin C and flavor were noted. The first detectible flavor change did not occur in the concentrates until after 6 months' storage at 100° F., and not until after 7 months in the juices.

Vitamin C was lost during storage of concentrates and juices at 100° F. At the end of 6 months, concentrates showed losses of 50–60% of their original vitamin C, whereas the juices showed losses of 40–45%. The effects of evaporation temperatures on stability of vitamin C during storage of concentrates were evident in these experiments. Vitamin C was most stable

in those concentrates evaporated at the lowest temperature, and least stable in those evaporated at the higher temperaure.

No darkening or swelled cans were noted in the concentrates during storage at 100° F. for 6 months; first evidence of swells did not occur until after 19 months at this temperature.

Concentrated tomato juice prepared at evaporation temperatures of 150° F. or lower compared favorably in quality and storage stability with canned single-strength juice, and they are more stable than tomato paste.

19

CHARACTERIZATION OF PECTIN CHANGES IN FREESTONE AND CLINGSTONE PEACHES DURING RIPENING AND PROCESSING

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Texture is one of the important factors influencing the quality and acceptance of canned peaches. It is related to the changes in relative amounts of protopectin and versene-soluble and water-soluble pectin in the fruit during ripening and processing. In this work, the changes in various pectin fractions during ripening and canning of Fay Elberta freestone and Halford clingstone peaches were investigated by the carbazole method. Results indicate that the firm texture of fresh clingstone peaches can be attributed to the lack of change of protopectin to water-soluble pectin during ripening. The amounts of protopectin and versene-soluble and water-soluble pectin in clingstone peaches did not vary significantly in samples with pressure tests ranging from 5 to 10 pounds. In contrast, as the pressure test of freestone peaches decreases from 12 to 0.85 pounds during ripening, protopectin and versene-soluble pectin decrease steadily, while water-soluble pectin shows a marked increase.

During canning, the protopectin content of clingstone peaches decreases slightly and the texture becomes softer. Cooking time affects the texture of the canned product more than the ripeness of the fresh fruit does. In freesone peaches, both ripeness of the fresh fruit and cooking time are important factors determining texture of the canned product. Factors influencing syrup viscosity, drained weight, and flavor of canned peaches are also considered.

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THE EFFECT OF SIRUP COMPOSITION ON CANNED CLINGSTONE PEACHES

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Several varieties of California clingstone peaches, selected as line samples from a commercial cannery and as carefully selected and sorted fruit under semi-commercial pilot plant operations, were canned in sucrose sirups and in blends of sucrose and corn sirups. The peaches were canned during each of the seasons of 1951–1955 under commercial conditions and in 1952, 1953, and 1954 under laboratory controlled conditions. The canned fruit was examined periodically to determine the effect of replacement of sucrose by corn sirup solids and corn sugar. Changes in appearance, texture, and flavor of fruit were observed. The extent of these changes was found to depend on the fruit used, the operations used in preparing the fruit for canning (particularly the method of lye peeling), the type of corn sirup used, and the extent of replacement. At the permitted level of replacement (25%) little if any difference in texture and flavor between the all-sucrose packs and the sucrose-corn sirup packs was observed except with low conversion corn sirups. At higher replacement levels toughening of the skin surface, loss in fruitiness and development of undesirable flavors occurred. The increase in toughness was investigated in some detail and found to be related to calcium content and certain constituents of corn sirups used. The most easily detected change in flavor was due to change in sweetness but development of as yet unidentified off-flavors occurred also. Peaches peeled by spray-peeling cup down method were more susceptible to toughening by calcium than those peeled by immersion lye peeling and oligosaccharides higher than di- or trisaccharides accentuated this toughening. The sugar present in the sirup added had a noticeable effect on the absorption and combination of calcium present in the sirup.

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THE BIOLOGICAL EVALUATION OF THERMAL PROCESSES

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The biological evaluation of thermal processes by means of inoculated pack studies is discussed. Various approaches to the study of the problems involved are considered with reference to (a) agitating processes; (b) conventional retort processes; (c) continuous cooker processes; (d) the standardization of suspensions; (e) the advantages of the use of thermophilic flat sour organisms; and (f) the calculation of process lethality from partial spoilage data and the D value of the suspension.

22

DRIED PRUNE PRODUCTS—SOME FACTORS INFLUENCING THEIR CORROSIVITY

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It has long been recognized that dried prunes are one of the more corrosive canned foods. Improvements in can materials have made commercial packing of prunes and prune juice feasible but considerable variation in corrosiveness is still present. This work was designed to investigate variations in dehydraton procedure, storage of the dried prunes, and leaching methods, and their effect on corrosivity of prunes as measured by service life when canned.

A large quantity of field-run prunes was dehydrated for various lengths of time and the resultant lots placed in storoge. Part of each lot was taken initially and at the end of 1½ and 4 years' storage for canning, both as prunes in water and as prune juice. The data show that the dehydrated fruit is more corrosive than the fresh, and that the intensity of corrosivity increases with further dehydration. The juice made from the prunes reflects this tendency.

Packs made after 1½ years' storage were much more corrosive than those made soon after dehydration in the case of prunes that had been held at room temperature or 85° F.; prunes held at 40° F. during this time did not greatly increase in corrosiveness. Prunes stored at room temperature and 85° F. did not show any definite trend after that time, although the 40° F. prunes showed a gradual increase in corrosiveness at 4 years.

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SUMMARIZING REMARKS

General commentary on papers presented at session on canning studies.

24

A CHEMICAL STUDY OF THE VOLATILE NITROGEN AND VOLATILE SULFUR FRACTIONS OF CHICKEN

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Volatile nitrogen and volatile sulfur of chicken cooked in water were studied as part of an investigation of poultry flavor. Nitrogen present in chicken broth distillate consisted of ammonia and occurred in concentrations of the order of 37 p.p.m. Taste panel evaluation of fractionated distillate showed that ammonia is of minor importance as a flavoring substance and that volatile flavor is associated primarily with the neutral or acidic portions.

Sulfur was found in chicken broth distillate at concentrations of the order of 0.5 to 3 micrograms per milliliter. In freshly prepared broth distillate, sulfur was accounted for entirely as sulfide as shown by the agreement between total and sulfide sulfur contents. At room temperature, sulfide sulfur in the distillate oxidized rapidly (79% in 48 hours) to non-sulfide form. Volatile sulfur evolved when chicken was cooked in water was also found to consist only of the sulfide form. During heating or reheating of chicken, hydrogen sulfide continuously evolved even after prolonged heating or exhaustive steam distillation.

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EFFECT OF ANTIBIOTIC SOLUTIONS ON THE MICROBIAL FLORA OF DRESSED POULTRY

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The effect of dipping dressed poultry in solutions containing added tetracycline, chlortetracycline, oxytetracycline, or streptomycin was investigated. Also, the storage life of eviscerated chickens maintained in ice water containing antibiotic-impregnated ice was compared with that of control birds. The uptake of water that resulted after dunking chickens up and down several times or after soaking for 10 minutes or 2 hours in water or in antibiotic solutions was determined and the residual level of antibiotic in the raw tissue was analyzed.

The effect of initial counts on the storage life of untreated or antibiotic treated birds was studied. Analyses were made of the numbers and types of microorganisms present on the surface of the bird or in the rinse water. Relative numbers of yeasts, chromogenic bacteria, staphylococci, coliforms, *Pseudomonas*, *Salmonella*, and *Bacillus* on control birds or antibiotic treated birds were compared. Information was obtained on the effect of each of several concentrations of antibiotic on the storage life of eviscerated poultry. Data collected during the course of these studies will be presented and discussed.

26

SMOKING TURKEYS

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In an effort to extend the market for turkeys it was found that smoking was a promising method of preservation. Curing and smoking resulted in a distinct product with an attractive appearance and color, pleasing aroma, firm texture, and delicate smoked flavor.

Results showed that an excellent product was obtained by curing in a solution (12 gallons water, 8 pounds cane sugar, 8 pounds salt, 8 ounces sodium nitrate) at 38° F. for 6 days; and smoking (a) country-style, at temperatures 90° to 110° for 6 days, (b) in a locker plant, at moderate temperatures 100° to 125° for 2 days, and (c) in a commercial smokehouse, at temperatures from 130° to 150° for 18 hours.

Products smoked by any one of the 3 methods were judged highly acceptable by the taste panel. All members of a panel of 100 judges found a difference in fresh and smoked turkey, and 67 preferred the smoked to fresh birds. A difference panel of 5 experienced tasters showed the smoked turkeys were different from the fresh bird in appearance, color, aroma, texture, and flavor. The white meat of the smoked turkey was an attractive pale pink, and the dark meat varied from gray to a decidedly deep pink. The meat had a well distributed cured and smoked aroma; the texture was uniform and firm, but definitely not tough nor stringy. The flavor was more delicate than that of fresh turkey, resembling somewhat a mild cured ham.

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THE EFFECT OF TEMPERATURE OF HEATING AND POST-MORTEM AGE ON THE WATER-HOLDING CAPACITY AND SHRINKAGE OF MEAT

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Tenderness, changes in tenderness with the post-mortem aging, shrinkage, and drip on freezing and thawing seem to be related to the water-holding properties of meat. These qualities in turn seem to be associated with the ion-protein and protein-protein interactions in the meat. A method has been developed to measure the water-holding properties of meat. Changes in the water-holding capacity of meat during cooking and the effect of sodium chloride and other additives on the meat shrinkage will be discussed. Loss of moisture on cooking increases with temperatures above 65° C. At temperatures of 55–65° C. a maximum in protein hydration occurs. pH of meat increases on heating, particularly in the temperature range of 40–70° C. when the heat denaturation of the muscle proteins is actually taking place. The degree of protein hydration also depends on the cations naturally present or added to the meat. The effect of Na^+ and K^+ on the water-holding properties of meat differs from the effect of divalent cations Ca^{++} and Mg^{++}. There is also a great difference between the effect of Mg^{++} and Ca^{++}.

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THE ACTION OF PHOSPHATES ON SAUSAGE PRODUCTS. I. FACTORS AFFECTING THE WATER RETENTION OF PHOSPHATE-TREATED MEAT

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The effect on the water retention of ground meat of varying ionic strength, pH, time, temperature and of introducing certain ions was investigated. Excess solution was added to the sample and the amount of excess measured after the samples were stored and centrifuged, and again after they were heated. From these data meat volumes were calculated. The principal additives employed were mixtures of sodium chloride and pyrophosphates. Others used to a limited extent were orthophosphates, calcium and magnesium chlorides, and potassium iodide. It was found that volumes of unheated samples increased linearly, as compared with those of heated samples, with increasing concentration of sodium chloride, and curvilinearly when samples were treated with pyrophosphate-sodium chloride. It was concluded that the effectiveness of treatments with pyrophosphates was non-specific, being primarily related to the ionic strength and pH of the solutions applied. It was also found that the effectiveness of treatments with pyro- or orthophosphate-sodium chloride mixtures, but not with sodium chloride, decreased as the temperature of application increased from 32 to 68° F. (0 to 20° C.). The results showed that a nearly optimum effect was obtained after storage for 16 hours at 32° F. (0° C.). It was found that the addition of I^- markedly increased retention of water. The addition of Mg^{++} increased and Ca^{++} decreased retention of water to some extent. Some of the factors influencing water retention as measured by the above-mentioned method were also found to affect the evaporation of moisture from samples heated at 167° F. (75° C.).

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EFFECT OF CONTROLLING ENVIRONMENTAL CONDITIONS DURING BEEF AGING

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Methods of reducing shrinkage, as well as the control of other variables relative to aging beef, are described. This study involves the use of ultraviolet radiation to control microbial growth under elevated temperature and humidity environments.

Paired beef sides, quarters, and wholesale cuts of different weights and grades have been aged under various temperature, humidity, air flow, and radiation conditions. Shrinkage, color, bacteriological, drip and cooking loss, and organoleptic comparisons were used to determine the differential effects of the various aging treatments.

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AUTOMATIC PILOT PLANT CONTROL IN THE DEVELOPMENT OF MICROORGANISMS

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A study has been made, using a 50-gallon pilot plant fermentor, of the feasibility of automatically controlling the sugar concentration in a yeast propagation.

The equipment utilized for these studies consists of a 50-gallon stainless steel jacketed reactor with overhead, baffled agitation. Novel features are: a central control panel for the operation of the system; provision for complete sterilization; dual-control temperature regulation; automatic antifoam control; metered sterile and humidified air supply; constant back pressure regulation; and a continuous, automatic, flow-type, pH control system.

Initial studies were made with shake flask yeast propagation to obtain data on variable(s) as a function for continuous, automatic control of the sugar level in fermentation.

It was shown that refractive index is a function of sugar concentration when measured in a cell-free sample. Adaptation to

pilot-plant scale was made utilizing a continuous control refractometer.

A liquid stream was taken from the fermentor and separated into two streams by a continuous laboratory centrifuge. The reasonably clear stream was then polished by an in-line filter, passed through the refractometer and returned to the fermentation vessel.

The refractometer recorder-controller operated a diaphragm valve attached to a reservoir containing sugar or molasses. As deviations from the set-point tended to occur (indicating that the sugar level in the fermentor had tended to decrease), additional molasses or sugar was added to the reaction vessel in order that a constant level of sugar might be maintained.

The possible advantages of such control are discussed in full detail.

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FUNGI ASSOCIATED WITH THE SOFTENING OF OLIVES AND CUCUMBERS IN STORAGE BRINES

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Salt brines in which cucumbers and olives are stored prior to processing commonly develop surface films of microorganisms by the time the desirable lactic acid fermentation has subsided. Molds and yeasts comprise the bulk of the microbial populations found in these films. It is well established that these strongly aerobic microorganisms, especially the yeasts, cause an undesirable destruction of the lactic acid which, in combination with the salt, preserves the olives or cucumbers. The literature gives some indication that these microbial films may contribute to softening of the olives and cucumbers in storage.

Thirty-seven pectinolytic fungi and one actinomycete were isolated from such brines by direct streaking on a sodium-polypectate gel medium. The purified, pectate liquefying isolates were identified as belonging to the genera *Fusarium* (26 isolates representing 6 species), *Penicillium* (9 isolates representing 3 species), and *Paecilomyces*, *Verticillium*, and *Streptomyces*, each represented by 1 species. These isolates produce softening of polypectate gels *in vitro* under a variety of conditions and are associated with the softening of olives and cucumbers.

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LINDANE RESIDUE IN CUCUMBER FERMENTATION

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A study of the influence of lindane (gamma-hexachlorocyclohexane), an insecticide, on the microflora of fermenting cucumber brine has been made. The results of 4 years' work on the problem are reported.

Lindane residue on the cucumbers in the fermenting brine resulted from two methods of application: (1) recommended spray concentration (one pound, 25% wettable, per 100 gallons) for insect control was applied directly to the harvested cucumbers prior to brining, and (2) insect and disease control schedules with lindane were applied to replicated field plots 6 times prior to harvest. Chemical and bacteriological tests were made during the fermentation to determine the effects of the residue.

The possible inter-relationship of lindane and i-inositol on the fermenting flora was explored. Controlled amounts of lindane and inositol were added directly to cucumber brines. Pure cultures of yeast and bacteria known to be in the fermenting flora were exposed to lindane and inositol in highly defined liquid media.

All the data were given a statistical treatment by the statistic Analyses of Variance. From the statistical analyses of the data lindane was found to affect the cucumber fermentation. A mechanism for explaining the observed effect is suggested.

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INFLUENCE OF PLASTIC VAT COVERS ON THE FERMENTATION OF CUCUMBERS

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Contamination in cucumber fermentation has long been a problem, but little attention was given to it until recently when the Federal Food and Drug Administration began investigations.

As a method of contamination prevention polyethylene films of 15, 20, and 30 mil gauges were used as vat covers. A microbiological study along with a chemical study was carried throughout the fermentation period. The bacteriological study revealed that there were no apparent differences in the growth of lactic acid bacteria between covered and uncovered vats as there was as much variance between duplicates as between treatments. There were observed differences in the amount of film yeast growth on the various vats but the differences and amounts were too insignificant to be of importance. No positive coliforms appeared. After a curing period, the cucumbers were carried through the pickling processes to further determine any differences that could be attributed to the type of coverage.

Insect and other filth contamination was greatly reduced in the covered vats.

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STATISTICAL ESTIMATION OF THE FIRST LAW OF THERMODYNAMICS AS APPLIED TO THE FERMENTATION PROCESS FOR SODA CRACKERS

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The present paper deals, essentially, with the statistical estimation of the joint dependence of temperature, quantity of carbon dioxide, the amount of acids generated by the first stage (sponge stage) of the fermentation process for soda crackers.

The theoretical concept which underlies the study is expressed by the first law of thermodynamics. It is shown that the application of the (kinetic) differential form of the first law of thermodynamics leads to a linear differential equation of first order with temperature and time as dependent and independent variables, respectively. The integration of the differential equation yields a linear form (linear equation) connecting current temperature (y_1) of the fermentation system, quantity of carbon dioxide (y_2), amount of acids (or degree of hydrogen ion concentration) (y_3), mechanical work done by the system (y_4), initial temperature of the system (z_1) and temperature of environment (z_2). This linear equation may be considered as one of a complete linear system of stoichiastic equations describing the fermentation process under study. The parameters of the equation (that is, the coefficients of the respective variables in the linear form) are then estimated statistically by the limited-information maximum-likelihood method (the least variance ratio principle) with y_1, y_2, y_3, y_4 as *endogenous* variables. The variables z_1, z_2, further pH (z_3) of the initial state of the system, diastatic activity (z_4), proteolytic activity (z_5), initial acid forming bacterial count (z_6) and initial yeast concentration (z_7) are considered, statistically, as *exogenous* variables. The design of experiments maintains constant relative humidity of the environment, constancy of initial substrates composition, constant initial (total) water content and invariable initial rheological state of the system. Hence, the only (experimentally) predetermined variable factors are exogenous variables (z-variables) described above. The indicated classification of endogenous and exogenous variables implies the over-identification of the linear equation under study and the least variance ratio principle produces limited-information maximum-likelihood estimates of coefficients of the equation, the derivation of which is indicated above.

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EFFECT OF CUCUMBER HOLDING TIME AND TEMPERATURE ON THE QUALITY OF PASTEURIZED FRESH WHOLE PICKLES

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This study was carried on to ascertain the rate of quality deterioration of cucumbers as reflected in the finished pickle product. Pickling cucumbers (variety SR-6) harvested from a commercial field were divided into 10 representative lots. One lot was packed immediately (as a control), the others were held at temperatures of 40, 60, and 80° F. for 24, 48, and 72 hours, respectively, before being packed as pasteurized fresh whole pickles. The pickles from the different treatments were compared and judged on the basis of appearance, color, and texture. Pickles made from cucumbers held for 24 hours at any of the 3 temperatures were acceptable, but inferior in quality to the controls. Longer holding times gave progressively poorer quality.

After 72 hours only those cucumbers held at 40° F. produced acceptable pickles. The relationships of the measured pickle quality factors with holding time and with holding temperature are linear.

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PICTORIAL INSTRUMENTATION

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This paper discusses graphic panel instrumentation and its relation to centralized process control. An entirely new concept in graphic panel instrumentation specifically designed for the food industry is presented. Examples of this pictorial instrumentation are cited.

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THE PLASTOMETER—A NEW DEVELOPMENT IN CONTINUOUS RECORDING AND CONTROLLED CONSISTOMETERS

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The Plastometer, a new continuous consistometer capable of indicating, recording, and controlling the consistency of food purées in production, is described. Measurements taken with it are directly related to the slope of the viscosity-shear rate curve. Excellent linear correlation has been found between the slope function as measured by the Plastometer and Bostwick or Adams hand type consistometer readings.

The design is based on a differential shear rate principle in which the difference in flow resistances at two different shear rates is the measured quantity. The two shear rates are obtained by flowing the purée through a sensing element containing tubing of two different diameters. The developed hydraulic pressures are subtracted from each other in a differential pressure transmitter, the difference being sent on to a pressure activated recorder or controller. No moving parts other than the sampling pump come in contact with the product. In contrast to the usual capillary tube type of viscosimeter the Plastometer is insensitive to minor variation in flow rate as produced by slippage, pump wear, etc.

Data demonstrating the correlation between Plastometer readings and Bostwick consistency measurements for various purées are presented.

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AN AUTOMATIC MACHINE FOR THE CONTINUOUS MIXING OF SOLIDS AND LIQUIDS TO THE RIGHT QUANTITY AND CORRECT VISCOSITY: ITS APPLCATION IN THE BREADING OF FROZEN SEA FOOD PRODUCTS

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As the trend from batch to continuous operation increases, the supply of process material to the line must also be placed on a continuous or automatic basis. The control of this material assumes more importance as it is delivered and used in such situations as a result of the increased rate of usage.

The blending of solids and liquids can now be effected and controlled continuously by the machine described in this paper. Its action is such that it will maintain the correct liquid level in a tank, sump, or enrober while at the same time controlling the viscosity of the liquid. This control, as well as the continuous mixing provided by the machine, is effective and self-compensating for different process loads.

Although completely automatic in its operation, the machine is designed for instant intervention on the part of an operator if events so require.

This paper describes the action of the system mentioned above, its form of interlocked control, and its application to the packing of frozen sea food or other breaded products. A comparison is made between the results obtained with automatic and continuous control and those observed in a manual mixing operation. The effects of the system on the quality of the finished product are also discussed, with particular reference to the importance of viscosity in the breading process.

Possibilities for the use of the machine elsewhere within the food industry are discussed.

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DIRECT STEAM INJECTION FOR HIGH TEMPERATURE SHORT TIME STERILIZATION OF WHOLE KERNEL CORN

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Use of high-temperature, short-time sterilization for liquid and even semi-liquid foods has become a commercial practice. High-temperature, short-time principles were applied to the sterilization of particulate food such as sweet corn. An apparatus was constructed for the steam injection sterilization of whole kernel corn in an open can. A continuous flow of high pressure saturated steam was used. Lids were separately sterilized and the cans aseptically sealed.

The method was evaluated in several ways. The rate of heat penetration into individual corn kernels was measured. Time to reach process temperature was about 30 seconds. Storage studies were made on cans inoculated with spores of NCA No. 1518. Five million spores in a No. 2 can were destroyed when the corn was subjected to steam at 269° F. for 150 seconds.

Organoleptic evaluations were also carried out. Immediately after processing under the above conditions the sterilized samples compared favorably to a frozen control. After 4 months' storage at room temperature they had developed an off-flavor believed to be caused by enzyme activity.

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EFFECT OF CONTINUOUS STEAM INJECTION OF TOMATO JUICE ON FILM DEPOSITION DURING SUBSEQUENT CONCENTRATION

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During the concentration of high hot break tomato pulp, as in the production of ketchup, a heavy film is deposited on the heat transfer surface. This film is extremely undesirable because it reduces the rate of heat transfer and thus necessitates frequent cleaning of the heating surface. The results of recent work indicated that pretreating the juice by means of steam injection would alleviate this problem.

A steam injection apparatus was fabricated and steam under controlled pressure was used. A variable speed pump forced the juice through the injector and a holding tube of variable length.

The temperature of the juice after injection and the length of time held at that temperature were the primary experimental variables. Pretreated juice and control samples were concentrated in an atmospheric cooker to one-third the original volume. The amount of film deposition was evaluated by recording the time required to concentrate a batch and visual inspection of the coils. Quality characteristics such as color, consistency, weeping, and solids were determined on initial, treated, and concentrated products.

Increasing the juice temperature and the holding time at that temperature reduced the amount of filming. Of the treatments used, heating the tomato juice to 280° F. and holding at that temperature for 3 minutes proved satisfactory.

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MEASUREMENT AND CONTROL OF THE MORE DIFFICULT PROCESS VARIABLES

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Application of newly developed techniques and adaptation of established laboratory methods for continuous measurement and control of variables contributing to food product quality, production rate, and package dimension will make possible automation in the food industry. Replacement of periodic sampling techniques by in-stream analyzers will speed the trend which has been the dominant recent development in the other major process industries. Research laboratories are providing the basic analytical procedures which will be expanded to become methods of controlling variables previously unmeasured or neglected in food manufacture.

The most promising new field for industrial gauging is based on transmission and scattering of low level radiation. Current work is leading to determination of mass, thickness, specific

gravity, composition, and level by measuring the effect on radiation of food material in process. Well-known spectrophotometric principles are becoming more widely applied with development of abridged apparatus designed to monitor particularly important variables including color and turbidity in food manufacture. Refractometric measurement can be brought to the production line by continuous sampling devices which actuate controllers to blend or dilute process flow to meet specifications. Ultrasonic methods of measurement, when well correlated with rheological theory, will provide measurements relating to tenderness and texture of products.

Utilizing advanced techniques such as these in combination with common process variable measurements, the Food Technologist and the Control Engineer will cooperate in developing and bringing to the plant well-designed control loops for the food production line.

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A PRACTICAL LOOK AT AUTOMATION FOR THE FOOD PLANT

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The term "automation" as generally accepted today began to be used with some degree of frequency about two years ago. It was immediately snapped up by economists, industrialists, and labor leaders and basically redefined to suit their own needs. Myriads of words have been used in describing the wonders of automation. We have all gone to great lengths to determine the potential effects of automation in our plants. In this approach we have, at times, clouded our views by thinking of automation in its more complicated form. This paper will deal with an interpretation of the term in a practical vein and and as a direct means to the simple solution of specific process problems common in our plants today. Effective quality control and economies of operation may be achieved by these primary, yet functional, applications of automatic control—economies that may not be realized and are not possible in manually controlled systems.

Automation does not solely apply nor by necessity become paramount for large production problems only. Effectively engineered, practically applied, and combined with equipment of proper design, automation may no longer be classified as a luxury, but rather as a means to attain economically a repetitive quality of product to meet specific conditions set up by improved techniques developed in our research divisions or laboratories. To illustrate what has been and can be done by these simple applications of automatic control and design, process problems will be examined and solutions to these problems shown to demonstrate that these principles may be readily applied by the Food Technologist in his own actual plant operation.

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EFFECTS OF CHLORTETRACYCLINE AND OXYTETRACYCLINE HYDROCHLORIDES ON THE CARCASS CHARACTERISTICS OF MARKET PIGS

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Antibiotics have been incorporated in swine rations for the past several years. Experimental workers have reported that the stimulation in the increased rate of gain is due to the increase in fat deposition. This project was designed to determine the manner of fat deposition, antibiotic carryover in the tissue, carcass and slaughter data, frozen storage potential, cooking, organoleptic and chemical analysis. Four trials were conducted over a three-year period using a total of 52 weanling pigs. Littermate pigs of the same sex were self-fed individually on concrete floors. The pigs were allotted at random into 3 groups: Group 1, basal ration; Group 2, basal plus 10 mg. of aureomycin HCl per pound of total ration; Group 3, basal plus 10 mg. of terramycin HCl per pound of total ration. The pigs were slaughtered at 225 pounds. Length of carcass, backfat thickness, leg length, ham length, depth of body, pocket thickness, and circumference of ham and hock were measured. The pH was recorded for the stomach, duodenal, large intestine and caecal contents, and for the liver and *psoas major* at 0 and 24 hours. Detailed cutout data and area of the cross section of the loin and ham were recorded. A physical separation of the 9th through the 13th rib was made. The *longissimus dorsi* muscle was analyzed for press fluid, total nitrogen, non-protein nitrogen, fat, and moisture. Fatty tissue was analyzed for peroxide, acid number, and refractive index. Loin roasts were frozen for 24 and 48 weeks when further analyses were determined. No traces of aureomycin or terramycin were found in the tissue. The aureomycin group gained the fastest and had the fattest carcasses. The terramycin group graded the highest. Chemical differences were not significant. Cooking and palatability scores did not show any significant differences among treatments.

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CHEMICAL AND PHYSICAL CHANGES IN ISOLATED BEEF MUSCLE TENDERIZED BY INFUSION WITH SODIUM CHLORIDE

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Tenderness is probably the most important quality attribute of meat, provided the meat is otherwise sound and fit for human consumption. In this study, *Biceps brachii* muscles were isolated from the right and left shanks of carcasses. One of the muscles from a pair was infused with 20% sodium chloride solution so that the salt content in the muscle was 2%. The other muscle from this pair was used as a control. Ten pairs of muscles were infused and held at 38° F. for 72 hours. After the holding time, tests were carried out with a taste panel for evaluation of tenderness. A number of chemical and physical analyses were also carried out on the muscles. In other studies, an experiment involving 15 pairs of muscles was designed on a statistical basis to remove the effect within and among the animals and also to study the effect of length of holding time after perfusion on tenderness and chemical changes.

Although infusion with salt increased the tenderness of the muscles, the reason for this as reflected in chemical changes is not clear.

Actin and myosin were extracted from each muscle and the extract was subjected to various analyses.

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INHIBITION OF HEMATIN-CATALYZED OXIDATIVE FAT RANCIDITY

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The hematin compounds—hemoglobin, myoglobin, and the cytochromes—are powerful catalysts for the development of oxidative fat rancidity in meat products. Using an emulsion system of lard with hemoglobin as catalyst, antioxidant and synergist mixtures were evaluated for their usefulness in preventing oxidative rancidity. The five most important commercial antioxidants gave increasing inhibition of hemoglobin catalyzed oxidative rancidity in the order: alpha-tocopherol, propyl gallate, nordihydroguaiaretic acid, butylated hydroxyanisole and butylated hydroxytoluene. Butylated hydroxytoluene and butylated hydroxyanisole were outstanding inhibitors.

A large number of nitrogenous compounds were evaluated as direct inhibitors of hemoglobin catalyzed lard oxidation. None were appreciably effective. Although the amino acids, lysine and histidine, were synergistic when used with nordihydroguaiaretic acid, it is not possible to predict synergism on the basis of hemochrome formation. Ascorbic acid was synergistic with all five of the antioxidants studied but was most synergistic with nordihydroguairetic acid.

Most effective inhibitors found for oxidative fat rancidity catalyzed by hematin compounds were multiple synergists. The synergistic system of nordihydroguairetic acid, butylated hydroxyanisole and ascorbic acid gave extended periods of protection both in model systems and when applied to pork and fish tissue.

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EFFECT OF SOME BIOLOGICALLY IMPORTANT COMPOUNDS ON RANCIDITY AND DISCOLORATION IN CURED MEAT

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A number of compounds occurring in muscle juice were tested in fat-aqueous systems as possible antioxidants. DOPA, and to a lesser extent a few phosphorylated compounds, curbed oxidative rancidity. Ascorbate and two other enediol compounds, dihydroxy fumarate and dihydroxy maleate, were found to be pro-oxidants, as were compounds of the –SH type (cysteine,

glutathione and protein bound –SH), to a lesser degree. Several antioxidant combinations will be described.

The enediols and SH compounds were also tested for their ability to accelerate the formation of nitrosohemoglobin in solution and to protect the color of cured meats. Cysteine, glutothione, and ascorbic acid protected the "cured meat" color of sliced comminuted meat which gave a negative test for -SH groups, and a positive test for nitrite. Cysteine gave much longer protection and much quicker color regeneration in the dark than did ascorbic acid of the same molar concentration. Dihydroxy fumarate and dihydroxy maleate were of no value in promoting formation of the cured meat pigmentation protecting the sliced meat from light decolorizations.

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SODIUM ASCORBATE IN STABILIZING CURED MEAT COLOR

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A technique of adding sodium ascorbate and other food additives to ham is described. This method involves the simultaneous injection of two solutions, one containing sodium ascorbate and the other sodium nitrite.

Paired hams differing in quality and weight were used. Reflectance measurements were taken of 5 muscles: namely, the *semitendenosus, biceps femoris, rectus femoris, adductor,* and *semimembranosus.* These measurements were taken throughout the prepackaged display period of 5 days. Dominant wavelength, color purity, and brightness as well as Munsell Color Notation for the treated and untreated ham were determined. Hams cured with added sodium ascorbate had a brighter, more uniform, red color than the controls cured with sodium chloride, sodium nitrite and sugar. The fixed color had more strength, and did not fade as rapidly when prepackaged and displayed under 60 foot-candles of light.

Also studied, was the effect of spraying 1 to 6% ascorbic acid solutions on both tenderized and fully cooked ham slices.

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EFFECT OF STORAGE CONDITIONS ON LOSS OF COLOR AND FREE SULFHYDRYL GROUPS IN CURED MEAT

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Previous work has shown that the fading of cured meats can be inhibited if sufficiently high concentrations of nitrite and protein sulfhydryl groups are present at the meat surface. The loss of sulfhydryl groups as affected by various storage conditions, including temperature, light, packaging material and the presence of excess nitrite, have now been investigated. Temperature was found to have the greatest effect. Light and packaging material had little influence on the destruction of the sulfhydryl groups. The concentration of nitrite proved to be of great importance both on sulfhydryl groups and on color fading.

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THE EFFECT OF REDUCING MICROORGANISMS ON THE RATE OF COLOR DEVELOPMENT IN CURED MEAT

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Used cover-pickle obtained from a commercial meat packing plant was found to contain predominantly microorganisms which were broadly identified by isolation as streptococci, yeasts, and bacilli.

The effect of these organisms on the rate and extent of color development during curing was studied. Fresh ham was cut and ground aseptically. It was blended with sterile curing solution and portions were inoculated with each of the test organisms. The samples were then incubated at 60° F. for 24 hours and finally heated to 120° F. The color development was measured throughout the curing process with the aid of a Photovolt Photoelectric Reflection meter and the Beckman Spectrophotometer with reflectance attachment. The pH, oxidation-reduction potentials, and plate counts were determined during curing at 60° F.

It was found in general that the organisms tested in these experiments improved the final color of cured pork. As a rule, yeasts seemed to be more effective than the others. The growth of microorganisms during curing at 60° F. was accompanied by a decrease in oxidation-reduction potential; hence it was reasoned that they improved the color by reducing the potential of the meat. The test organisms themselves did not reduce nitrates.

This paper describes a method for studying the effects of microorganisms on the meat curing process.

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USE OF ORGANIC REDUCTANTS IN THE CANNING OF LUNCHEON MEAT

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Slight brown discolorations sometimes develop in the surface portions of canned pork luncheon meat at areas contiguous to the sideseam or to the "score" of key-opening cans. The literature of the meat-curing process suggests that the nitrite of the curing salts is in equilibrium with nitric oxide (NO), nitrogen dioxide (NO_2) and water. Nitric oxide is the real curing agent, reacting with the natural meat pigment to produce the red nitric oxide myoglobin, which is still a complex derivative of ferrous iron. Nitrogen dioxide tends to oxidize some of the meat pigment from the ferrous to the ferric complex, and the brown metmyoglobin so formed constitutes the discoloration. The existing evidence suggests that in the present instance the metallic ions from the exposed areas of the can are merely catalysts for this reaction and do not enter directly into the composition of the discoloration.

Several years ago it was discovered in this laboratory that the discoloration could be reduced to commercial insignificance if the meat were packed in cans containing small areas of metallic aluminum in the end construction. Recently various laboratories connected with the meat industry have shown that the use of ascorbic acid as a constituent of the curing salts gives a better cure and increased stability of color in the ordinary refrigerated distribution of canned meats. In the present investigation it has been found that ascorbic acid will also prevent the discoloration specifically encountered with canned meat products. Certain considerations pertaining to the chemistry of the system are pointed out and certain other reductants have been investigated. The results are in part illustrated by color slides.

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ANALYSIS OF ANTIOXIDANTS IN EDIBLE FATS

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An informal review of observations on butylated hydroxytoluene, butylated hydroxyanisole, propyl gallate, and NDGA. Combinations of these antioxidants (except those containing both propyl gallate and NDGA) will be considered.

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A CONTINUOUS PROCESS FOR DEHYDRATING FRUIT JUICES

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An increased interest, particularly by the Army Quartermaster Corps, is being shown in the development of fruit juices in dried, solid form. Powdered apple and grape juice products have already been made successfully by the authors, utilizing a batch techinque in which the juice is shelf-dried under vacuum. These powders possess excellent keeping properties at room temperature, and at 100° F. much better than the corresponding liquid concentrates.

In order to find a cheaper drying method which would be commercially practicable a continuous technique has been investigated. Juice concentrate is dried continuously in a controlled turbulent thin film evaporator under vacuum, utilizing relatively high temperature but short processing time. While in a molten state, the concentrate is reduced to 2% moisture. It is pumped from the evaporator and a metered stream of high-fold essence is injected into it with thorough mixing. The mixture is embrittled on flaking rolls. Coarse crushing and pack-

aging in 4-ounce cans with a desiccant envelope complete the process. So far this method has been tried on a pilot-plant scale to produce apple, grape, and cherry juice powders.

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LOW-MOISTURE RED SOUR PITTED CHERRIES

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Low-moisture red sour pitted cherry pie stock was prepared from frozen red sour pitted Montmorency cherries. Fresh pitted cherries were treated, frozen on trays, and stored at -10° F. They appear to be stable for long periods while in the frozen condition. The frozen cherries were dried directly *in vacuo* on trays held at 140° F. No heat damage, no significant losses of flavor, and no losses of product occurred. The weight of the product is 15% of that of the fresh pitted material. In the dry condition it had a dark natural red color and was only slightly collapsed in appearance.

Data will be presented on stabilizing additives, freezing, drying, and packaging methods, storage stability, and organoleptic evaluation. This low-density pie stock had unusual stability. When stored for 6 months at 100° F., it was rehydrated readily and baked into a highly acceptable pie. The reconstituted cherries in pie form were red in color, possessed a smooth skin texture, and a desirable cherry flavor.

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THE STORAGE STABILITY OF FREEZE DRIED PEACHES

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The rate of deterioration of freeze-dried peaches was compared to that of conventionally dehydrated peaches at a storage temperature of 110° F. The changes were followed over a period of 120 days. Rates of color changes were determined by measuring the color of rehydrated samples at intervals during storage. A three-filter colorimeter was used for the color measurements, and data so obtained converted to tristimulus values for comparison. The variables studied were SO_2 level, moisture content, and the effect of dehydration prior to freeze-drying.

The rate of color change in peaches which had been freeze-dried to a very low moisture content was found to be substantially lower than those which had higher moisture contents. Conventional dehydration did not produce peaches of as low a moisture content as were produced by freeze drying, so that in these the rate of deterioration was invariably higher. The addition of sulphur dioxide to peaches before dehydration lowered the rate of color change during the early stages of storage, but despite this their color changes were greater than those of the lyophilized peaches after 60 days.

When peaches which had been dehydrated to 30 and 50% moisture were freeze dried, the rate of moisture loss was lower than that of peaches which had no prior dehydration. In these cases the time required to reach a moisture content below 5% was in excess of the time required to completely freeze dry a fresh sample.

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ADVANCES IN THE DEHYDRATION OF MASHED POTATOES BY THE FLAKE PROCESS

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If new and improved potato products can be made at a cost atractive to producers, more of them will be made and more will be sold. The over-all food use of potatoes may thereby be increased.

Potato flakes are a new and attractive form of dehydrated mashed potatoes of excellent appearance, flavor, and color. They are made by a single-stage drying process on drum driers. Earlier papers have described the process as originally developed using a two-square-foot double drum drier, and have discussed the factors controlling the texture of the reconstituted product.

This paper reports the results of experiments with larger-scale pilot-plant equipment capable of dehydrating 200 to 300 pounds of mashed potatoes per hour. The dehydration is done on a single-drum drier, 2 feet in diameter and 3 feet in length, of the type customarily used in making potato flour. Because of the method of application of feed to this drier (by means of "spreader" rolls) higher product rates, higher evaporative rates, and denser product sheets can be obtained.

The operation of the pilot plant is described and pictured, with emphasis on the operation of the single-drum drier. The effect of solids content of the feed on feed pickup rate, evaporative rate, product rate, and product density is shown. The effect of drum speed on product density is given. Other factors bearing on the cost of production, such as steam requirements, are discussed.

Some calculated cost data are included. The effect of raw potato cost and solids content on product cost is shown.

Since tolerance for high-temperature liquids of reconstitution and long steam table life are important current aims in the industry, results of recent improvements in potato flakes through the addition of small amounts of glycerol monopalmitate are included.

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PREPARATION AND EVALUATION OF PRECOOKED, DEHYDRATED BEAN PRODUCTS

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Precooked, dehydrated foods due to their ease of preparation appear to offer the means of reducing military requirements for food service equipment and personnel. In addition these light weight foods would reduce demands on transportation and storage requirements. Production of precooked dehydrated bean products provide a variety of popular food items in the desired form.

Dehydration studies indicate that there is a definite correlation between rehydration characteristics and cooking methods, pretreatments, and dehydration conditions. Very promising products have been produced utilizing red kidney beans and white bean varieties such as Great Northern, Michigan Pea (Navy), and California. All dehydration was conducted using a through-flow cabinet type dehydrator.

These products were found to be adaptable for use in completely precooked dehydrated combination type dishes such as beans and franks, beans in tomato sauce, chili con-carne, stews, and soups.

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THE EFFECT OF BREAKING THE SKIN ON THE CROSS-CIRCULATION DRYING OF GREEN PEAS

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In experiments on the rehydration of dried peas it was noted that some peas more nearly regained their normal size than others. On closer inspection it was found that these peas had broken skins. Other experiments followed in which peas were punctured with needles before rehydration, and these also regained much of their normal shape. From this it was concluded that if the skin was broken by puncturing or slitting before drying the rate of dehydration would also be hastened. Of the two methods, slitting the skin seemed to offer more possibilities of achievement on a production scale. From the manual slitting of skins in the laboratory with razor blades, the operation was advanced to pilot plant stage by the construction of a continuous slitter in which the peas were fed onto a belt and rapidly carried under a series of revolving knives. The slit peas dried faster and to a lower moisture content and had a greater rehydration capacity.

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PREPARATION, PRESERVATION, AND QUALITY OF DEEP FAT FRIED PRODUCTS OF CERTAIN FRUITS AND VEGETABLES

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A series of experiments were conducted to study the possibilities of new deep fat fried products of certain fruits and vegetables. The following fruits and vegetables were included in the experiments:

Eggplant (Burpee's Hybrid and an unnamed variety from Iran)
Squash (Buttercup and Blue Hubbard)
Apple (Winter Banana, Golden Delicious, and Jonathan)
Lima beans (Fordhook Concentrated, Limagreen, and Clark's Bush)
Beets (Early Wonder and Perfected Detroit)
Carrots (Danvers Half Long and Imperator Regular)
Parsnips (All American and Hollow Crown)
Radish (Early Scarlet Globe and French Breakfast)

Mature fruits of eggplant, squash, apple and mature (not dried) seeds of lima beans and mature roots of beet, carrot, radish, and parsnip were selected. They were thoroughly washed and adhering water was absorbed in a cheese cloth. The fruits and roots were then sliced with a uniform thickness of 3/16 of an inch and whole shelled beans of lima beans were used. The samples from the respective crop were fried, at a temperature of 320° F., in three different shortenings. The frying was judged to be completed when bubbling in the shortening stopped. The fried products were weighed to determine the percent of recovery. A taste test was conducted. Fried lima beans and the chips of carrots, beets, and apples were preferred over potato chips. However, radish and parsnip chips were acceptable to certain judges after addition of garlic salt.

The quality of the product was related to the selection of the variety of the crop, the maturity of the crop, and the frying fat. The products were stored in paper bags for a period of 4 months; the chips of carrots, beets and lima beans were preserved in excellent condition. That these products have certain nutritional values seems evident and because of their longer shelf-life, they may be easily adopted to use in military rations.

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SOME RECENT WORK ON DEHYDRATION IN THE UNITED KINGDOM

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Satisfactory compression of dehydrated cabbage shreds, carrot dice, strips, and slices has been achieved by a simpler technique than used previously. A variety of partially cooked vegetables which require only 3 to 5 minutes boiling for complete reconstitution have been prepared and are suitable for inclusion in soups. Comparison of scalding vegetables in water and in steam before dehydration has been carried out on a factory scale and reasonably accurate assessments of the losses and yields resulting from the two techniques have been obtained. Storage life at high temperatures of steam scalded potatoes was less than that of those water scalded, but steam scalded carrots and cabbage have greater resistance to browning than corresponding water-scalded materials.

Various methods of pretreatment, both chemical and physical, failed to effect any appreciable improvement in the rate of reconstitution and the texture of VCD raw meats. With improved vacuum in the drying cabinet, ice sublimation became practicable. By employing this technique in the early stages of drying, dehydrated animal products with rapid rehydration characteristics and suited to a wide range of cooking techniques, have been produced on a large scale, *e.g.*, dehydrated precooked minced meats which are ready to eat after bringing to the boil in cold water. These items could form a basis for dehydrated precooked meals. The storage life of the dehydrated raw meats was less than that of the precooked minces, and an oxidative deterioration not inhibited by antioxidants is being investigated.

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INTEGRATED QUALITY CONTROL

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Are our quality control measures as dynamic as they could be? Are we operating in the shadow of *negative quality control?* That is, are we constantly striving by inspection methods to detect poor quality and thus prevent the sub-standard product from reaching the consumer? Is this what we call quality control? That is the pitfall we were in up to a few years ago. And, try as we might, we were unable to make the negative approach to quality control work. We found out the hard way that one cannot inspect bad quality *out*—one must build good quality *in*.

Working with this thought in mind, we tried to develop a *positive quality control*. That is, we attempted to apply positive thinking to quality control in order to foresee and thus attempt to eliminate some of the pitfalls of poor quality. This paper presents our experience in attempting to apply this thinking to a large baking operation.

By approaching various departments with this thought, we met with some success. We soon learned, however, that we must do even more. That to be really successful, we must unite all the quality control functions into a common cause in order to get the long range benefits. Webster defines such a process when he defines "*Integrate*" as "to unite or become united so as to form a complete or perfect whole." From this we developed the concept of "*Integrated Quality Control*."

Our outline for this type of quality control is:

1. Raw Material quality control.
2. Process quality control.
3. Product quality control.
4. Quality control and personnel training.
5. Quality control and public relations.

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EFFECTS OF TEMPERATURE AND RELATIVE HUMIDITY ON RATE OF DEFROSTING OF COMMERCIAL BREAD

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Successful application of freezing to preserve freshness of bakery goods depends upon proper handling during all phases of the process. Defrosting procedures are very important for satisfactory retention of quality of product and sometimes critical for maintenance of wrapper appearance. The present experiments concern effects of variations in temperature and humidity conditions on rate of defrosting of bread and on condensation of moisture on both product and wrappers.

Air temperature had the greatest effect on time required to raise the temperature at the center of a loaf from 0° F. (-18°C.) to 70° F. (21° C.), although relative humidity also exerted a discernible effect. With both wrapped and unwrapped bread, copious condensation of moisture from air of high relative humidity was generally associated with a small decrease in defrosting time. Potential economic gains, however, were offset by undesirable effects on wrappers. Best results at all temperatures studied were obtained with relative humidities between 40 and 60%. At lower relative humidities, undesirable drying of surfaces of unwrapped loaves occurred.

Simultaneous defrosting and "re-freshening" of frozen bread by microwave heating was only partly successful. Sufficient heating to freshen bread crumb to an acceptable extent also caused both cellophane and common waxed-paper wrappers to become seriously damaged.

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A SHORT METHOD FOR STRUCTURAL RELAXATION IN DOUGH

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The method of describing dough properties by means of a structural relaxation curve obtained from load-extension diagrams, made with Brabender Extensograph, has been described in several publications from this laboratory. It is considered to provide a more basic and hence a more meaningful description of dough properties than can be obtained from diagrams themselves. Although the new technique has been used in a variety of fundamental studies on the chemistry and rheology of dough, the method in its present form appears to be rather complex for routine use in control laboratories. A simplified structural relaxation procedure has therefore been developed; relaxation constants are obtained from two extensograms, one made at 10 and one at 75 minutes after shaping the dough sample. The method will be discussed in detail and illustrative experimental data will be presented.

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DEVELOPING NEW WHEAT VARIETIES IN NORTH DAKOTA FOR INDUSTRIAL ACCEPTANCE

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Progeny from crosses between wheat parents differing markedly in both agronomic and quality characteristics exhibit a wide

range of properties, which may exceed the range existing between the original wheats. In developing a new variety for rust resistance it is necessary to use one parent at least which carries resistance, although the variety may be poor in quality. The other parent then, while it may be lacking in resistance, must be of acceptable quality. Hybrids which excel in rust resistance and are satisfactory in milling and baking properties are selected, increased and the seed purified so that the variety will be uniform and true to type when released. Typical results are shown for test weight, protein content, flour yield, baking quality, and mixing requirements for representative hybrids. These values must fall within an acceptable range for the wheat to be approved. Possible techniques for reducing the material and time required for quality evaluation are discussed.

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APPLICATIONS OF THE IRISH MOSS—PROTEIN REACTION IN FOOD PRODUCTS

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The use of gelling agents in food products has long been known. Extractives of both animal and plant origin which form a matrix in water solution are commonly used in food products for thickening and for assisting in maintaining relatively heavy materials in suspension. Certain of the vegetable extractives—notably carrageenin or Irish Moss—have the additional property of forming reaction products with certain proteins in water suspension. First discovered to be true for milk and ice cream products, similar reactions with other proteins are now known. Egg white and soy protein extracts in water suspension show easily observed reactions with Irish Moss extractives. Wheat flour protein and Irish Moss reactions have been measured on physical testing equipment. Legume proteins also demonstrate a similar type of reaction. Food products in which flour, egg, milk and legume proteins are important factors present possible practical applications of this principle.

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SESAME

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Sesame is an oil-bearing seed that ranks as one of the highest in oil content. It has long been cultivated by man. Sesame possesses unique characteristics. It is starch free and of high protein value. Present in the seed are antioxidant compounds, sesamoline and sesamol, responsible for the exceptional keeping properties of the oil. Sesame has been known and utilized for its flavor value, but only on the surface of bread and rolls. Much of the flavor value and oil-antioxidant potentialities of sesame have gone unrealized because of the rather sturdy structural nature of the seed which effectively binds these properties inside the seed envelope. Dehulling or removal of the seed coat followed by heat processing yields a new type of sesame product. Grinding this processed seed releases the oil and yields a flavor-rich mass. Antioxidant value is high. Several food products besides bread and other baked articles present possible points of application of the flavor and other properties of this heat treated sesame.

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SOME OBSERVATIONS CONCERNING ENDOSPERM PROTEINS OF WHEAT

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Professor Hess will comment on his research on the morphological aspects of the endosperm proteins of wheat and the import of his findings.

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RHEOLOGICAL MEASUREMENTS OF PHYSICAL PROPERTIES OF FOOD IN RESEARCH AND PRODUCTION

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Continuous recording apparatus for the measurement of physical (rheological) properties in either the plant or the laboratory have now been developed to such a high degree of dependability that they find more and more application in food processing.

Continuous recording viscometers, plastometers, and hardness sensing elements are used for these measurements. They can be used either for research or for quality control purposes. Sensing elements have now been developed for the continuous measurement of rheological properties on production streams during processing. These are available in many sizes and operate under almost any pressure required. Physical properties such as viscosity and plasticity, newtonian as well as non-newtonian, can be recorded. Elasticity of plastic materials as well as hardness can be measured continuously. These instruments carry out measurements under controlled temperature, either constant or increasing or decreasing, at a constant rate. Instruments are now sensitive enough to detect the effect of trace ingredients, so long as they change one or more rheological properties. These instruments are rugged enough for plant application. Here are a few examples of applications out of many which are possible:

1. Viscosity, plasticity, gelatinization, and coagulation properties of puddings, gelatin, breakfast foods, and dry soups.
2. Dry skim milk, butter, margarine, lard, and the changes caused by hardening ingredients or processing.
3. Processed cheese and additives to change its plastic properties.
4. Chocolate products and coatings and the changes caused therein by different fats, lecithin, and other ingredients.
5. Fish and meat paste and sausage fillers and their behavior in automatic packing equipment.
6. Hardness measurements of solid type foods and their grinding properties.
7. Hardness testing of brewer's malt for the determination of the degree of solubility of malt.

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RESEARCH IN HIGH TEMPERATURE SHORT TIME STERILIZATION

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All high temperature short time processes involve some method of rapidly heating and usually some method of rapidly cooling the product. The potential product improvement results from: 1. Elimination of overcooking of one portion of a can's contents in order to assure sterilization of a slower heating portion. 2. The relatively greater increase in the rate of bacterial destruction over chemical reaction at higher (than normal) processing temperatures.

No one method of high temperature short time processing is applicable to all products. Methods studied over the last 25 years include: aseptic canning (presterilization followed by aseptic filling and closing), processes involving preheating of product, hot filling and closing (under pressure for non-acid products), holding to complete sterilization and cooling; steam sterilization of discrete particle foods in open cans followed by closure under steam pressure and cooling; agitation of liquid, brine packed and vacuum packed products to increase the rate of heating and permit high short processes.

The principal advantages of high temperature short time processing are improved color, flavor (reduction of cooked flavor) and higher vitamin retention. Problems are changes in texture, consistency, and, in some cases, rapid color or flavor changes in storage.

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AN APPARATUS DESIGNED FOR THE RAPID ELECTROCHEMICAL ESTIMATION OF FLAVORS IN VEGETABLES

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An electronic apparatus has been developed on which definite and reproducible quantitative responses to at least certain of the volatile flavoring constituents of vegetables can be rapidly recorded. Whether all aspects of that part of flavor which is due to volatiles can be measured and whether results at a series of electrodes can be accurately correlated with the subjective responses of large panels of tasters remain to be determined.

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SOME OBSERVATIONS ON RED PEPPER. I. ISOLATION AND ANALYSIS OF CAPSAICIN

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Red pepper is used as a seasoning in food for color and pungency. Capsaicin has been identified as the chemical agent largely responsible for pungency in red pepper but a suitable method of measuring pungency has escaped research workers to date. Methods for isolating, purifying, and identifying capsaicin are presented. A suggested method for measuring pungency in ground red pepper and oleoresin of red pepper is given.

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TRIOSE COMPOUNDS IN MAPLE SYRUP

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The characteristic color and flavor of maple sirup are formed during the atmospheric evaporation of sap from the hard maple tree. The sap as it comes from the tree contains about 2% solids of which 99.5% is sucrose, the remainder consisting of organic acids, nitrogenous material, and several oligosaccharides. However, fermentation by adventitious microorganisms causes a partial inversion of the sucrose to glucose and fructose. From these constituents are formed the color and flavor of the sirup.

In studying the changes that take place in the sap during its concentration by atmospheric boiling, it was discovered that the sap passes through a stage in which its reaction is alkaline. This suggested the possibility of alkaline degradation of the hexoses to trioses (3-carbon carbonyl compounds) as part of the mechanism of color and flavor development. A mixture of 2,4-dinitrophenylhydrazine derivatives was prepared from the steam distillate of a maple sirup. This mixture was chromatographed to give eight fractions from which crystalline compounds were separated that were closely related by their solubilities, color in alkaline ethanol, melting points, and absorption curves to the 2,4-dinitrophenylhydrazones of acetol, methyl glyoxal, glyceryl-aldehyde and reductone. An intensive study of these carbonyl compounds of maple sirup is now under way.

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ON THE COLOR OF COFFEE

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Color problems in foods frequently involve determination of degradative changes in the product through change in color. Color may also be an important criterion of quality. In coffee, however, the problem becomes one of determining conditions necessary for the development of a desired color during the roasting cycle, since the characteristics of the brew, prepared under standardized conditions, are affected by the roast. In order to define these conditions, the relationship between roasting temperature, degree of grind and source of coffee bean has been studied with respect to: (1) the color of roasted ground coffee, (2) the color of aqueous extracts prepared under standardized conditions, (3) the relative concentrations of ultraviolet absorbing components in the aqueous extracts. Rate curves describing the development of the brown color with increasing temperature of roast have been defined for coffee beans from several areas in Central and South America. A method is suggested for predicting the roasting conditions necessary for the development of a desired color in a given sample, or, conversely, for predicting the color of a sample roasted at a given temperature. In addition, aqueous extracts of beans roasted at different temperatures have been examined for differences in color and in colorless components with highly characteristic absorption in the ultraviolet. Intercorrelation of these results suggests means of predicting roasting conditions necessary to produce a grind and hence a brew of a desired color. The methodology of determining color of the ground coffee and of the aqueous extracts is discussed.

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INVESTIGATIONS OF DETERIORATION IN COOKED OYSTERS

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To aid in the development of prepared oyster products, the rate and type of deterioration which occurs in cooked versus uncooked oysters were determined. Changes in odor, pH and liquor losses during refrigeration were observed.

Oysters which had been cooked long enough to completely inactivate the enzyme catalase and subsequently stored at 5° C. developed a "fishy" odor within 4 to 6 days, while uncooked oysters developed a sour odor and showed a fall in pH. Evidence is presented to show that the deterioration characterized by the "fishy" odor is probably of an oxidative type. Because it was not possible to establish this by direct analysis of the fat, the problem was approached indirectly by determining whether or not the spoilage symptoms could be inhibited by fat antioxidants. The addition to the cooking water of small concentrations of a commercial liquid smoke or of a commercial mixture containing butylated hydroxyanisole and nordihydroguariaretic acid was effective in inhibiting the development of the "fishy" odor both in refrigerated and frozen oysters.

It was observed that oysters not only shrink and lose considerable weight during cooking, but that they continue to exude fluid during subsequent storage. The percentage of weight lost during cooking increased as the cooking time was lengthened. However, the larger the percentage of fluid cooked out of the oysters, the smaller was the percentage of fluid exuded during subsequent storage.

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A SIMPLE APPARATUS FOR DETERMINING GAS PERMEABILITY OF FLEXIBLE PACKAGING FILMS

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Selection and specification control of flexible packaging films for use in vacuum and inert gas packing of foods would be easier if there were a suitable method of measuring gas permeabilities of low permeability films. Methods of determining gas transmission rates of such films using two different gases at the same pressure on opposite sides of the sample and depending on partial prssure difference as the driving force are not sufficiently accurate. Commercially available equipment which uses gas on one side of the film, a vacuum on the other side and measures gas permeability manometrically is expensive and fragile. A simple, inexpensive, fairly durable cell employing vacuum and a manometric method of measuring gas permeability rates has been developed and will be described. Gas permeabilities of flexible packaging films determined by the method will be presented to show the range of permeabilities of packaging films. Data will be preesented to show the reproducibility of the method. This new gas permeability cell is recommended for evaluation of films to be used for vacuum or inert gas packaging of foods and as a quality control tool in maintaining specifications of such films.

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FLAVOR PERMEABILITY IN FOOD PACKAGING AND ITS EVALUATION

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The determination of flavor and odor transmission through barrier materials is of considerable importance in the packaging of many food products. Considerable work has been done along these lines in the past, but a completely satisfactory quantitative method is not yet available.

The authors have undertaken an investigation of the feasibility of application of the "Volatile Reducing Substances" method of Lang and Farber to the quantitative measurement of transmission of organic volatiles through packaging materials. It was found that the method yields quantitative results only when certain experimental factors are carefully controlled. Those limitations which apply also to measurements of volatiles in food products have been studied and are discussed in detail.

A procedure has been developed on the basis of above-mentioned considerations. Results obtained on several packaging materials using representative flavor and odor components are described.

An outline of future work, modifications of the procedure for routine quality control purposes, and possible further applications of the method are also presented.

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"MYLAR" POLYESTER FILM IN FOOD PACKAGING

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The characteristics and performance of a new packaging film, "Mylar" polyester film, are discussed. A brief history of the development leading to commercialization will be presented. The basic chemical and physical properties pertinent to food packaging will be shown in comparison to other commercially available packaging films. The limits of utility of "Mylar" film as they are now known will be shown.

A description of the techniques of fabrication of the film into useful food packages will be discussed. This will include a discussion of adhesives, solvent sealing, heat sealing and forming applicable to manufacture of bags, window cartons, formed containers, overwraps and bundles. Some combinations of "Mylar" with other materials which are applicable to food packaging will be included.

Specific applications of this film used as a food container will be presented and discussed. Performance of specific packages will be characterized by laboratory and field data.

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THE EFFECT OF GAMMA IRRADIATION ON CAKE MIXES CONTAINING HIGH AND LOW MOISTURE LEVELS

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The effect of gamma irradiation on cake mixes has not been extensively investigated. For this reason it was decided to determine the gross effects of irradiation on cake mixes at both high and low moisture levels. Cake mixes were irradiated as batters and as a dry mix since it was theorized that the higher moisture levels would accentuate any changes in the cake characteristics.

Canned batters were irradiated at 10,000, 30,000, 100,000, 700,000, and 2,000,000 rep. The samples were refrigerated except for the brief period of exposure to irradiation in the canal.

It was found that levels of irradiation at 100,000 rep, or above, harmed the cake-baking properties of the batters resulting in off color, low volume, gelatinous cakes. Standard analysis of the batters showed no change in total sugar, reducing sugar, total fat, iodine value of the fat, monoglycerides, acidity or pH at any of the levels of irradiation. A change occurred in the gelatinization properties of the starch as the number of rep increased. No differences were detected in alpha amylase activity.

Levels of irradiation necessary to produce an appreciable decrease in number of bacteria destroyed the cake-baking properties of the batter.

Irradiated dry cake mixes have recently been placed in storage. They showed no changes initially in the aforementioned standard analysis. Initial bakes showed no obvious change in cake-baking characteristics through 100,000 rep; however, at 500,000 rep the cake-baking properties were destroyed, resulting in dark, low volume, gelatinous cakes. The results of the storage tests will be reported at a later time.

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RADIATION STERILIZATION OF WHEAT IN RELATION TO RESPIRATION, BIOCHEMICAL CHANGES, AND BREAD-MAKING PROPERTIES

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Heating and deterioration of damp grain in storage, due primarily to the growth of saprophytic fungi indigenous to the seeds has been traditionally controlled by drying. Chemical preservation as an alternative means of control presents numerous unresolved difficulties. The present report deals with determination of gamma radiation levels to sterilize wheat, when damp or dry, in terms of elimination of spoilage microorganisms and other biological agencies as indicated by subsequent respiratory patterns. The effect of such treatment on the biological, biochemical, and technological properties of the grain was also evaluated.

Sterilization was accomplished in hard red winter wheat when damp (20% moisture), and dry (12% moisture) in the dosage range from 250,000 to 625,000 rep. The minimal dosage required for the dry grain was about 250,000 rep. Respiratory quotients were markedly elevated in radiation sterilized wheat samples, in comparison with the value of near unity exhibited by samples irradiated at lower dosage levels, in which mold growth persisted. Germination of the seeds was eliminated in grain containing 20% moisture at dosages beyond 125,000 rep but dosages greater than 625,000 rep were required to destroy viability in grain containing 12% moisture. Fat acidity was not affected by dosages as high as 3,750,000 rep.

Technological and biochemical properties of the wheat in terms of farinograph dough development curves, sedimentation value, protein solubility, fat acidity, fluorescence development, and bread quality, were essentially unchanged at an irradiation level sufficient to prevent all biological deterioration (250,000 rep). Indeed wheat treated with 125,000 rep exhibited an improvement in baking quality analogous to the effect of potassium bromate.

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THE EFFECT OF TEMPERATURE AND INTERMITTENT RADIATION ON THE ACCEPTABILITY OF MEAT

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Ground beef inoculated with a radio resistant micrococci was subjected to varying dosages of gamma radiation while at temperatures ranging from 0° to 150° F. A series of samples of ground beef were submitted to intermittent radiation to accumulate 2×10^6 rep.: Series A received 2×10^6 rep in 1 exposure; Series B, 2 exposures of 1×10^6 rep each; Series C, 4 exposures of 0.5×10^6 rep each, and Series D, 8 exposures of 0.25×10^6 rep each.

The effects of these treatments on the bacteria, chemical analysis, and acceptance of the irradiated meat were determined.

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ORGANOLEPTIC STUDIES OF IRRADIATED FOODS

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It has been obvious from the first that the appearance and flavor of radiation sterilized foods will determine acceptance by either the military or the civilian market. The characteristic advantage of sterile canned food lies in its storage stability. Canned products are expected to retain a high degree of acceptability over extended periods of storage. Certainly, similar demands will be made of radiation sterilized foods.

In order to obtain some information on the effect of storage on the organoleptic qualities of meats, irradiation sterilized beef, beef tenderloin, cured pork luncheon meat, and ham in 211 x 300 cans were stored at 40°, 70°, and 100° F. and examined at periods up to 3 years.

To obtain similar information on vegetables, irradiation sterilized asparagus, green beans, broccoli, brussels sprouts, cauliflower, and peas in 211 x 400 or 303 x 406 cans were stored at 40° F. and 70° F. and have been examined at periods up to 2 years.

A panel of 10 experienced tasters graded unidentified irradiated samples and frozen or thermally sterilized controls for flavor characteristics at the American Can Company laboratories at Maywood and Barrington. Statistical analysis of taste test scores showed significant off-flavor in each of the meats and vegetables which had received 2.6 or 3.0 million rep gamma radiation. In every case important changes in appearance or flavor developed on storage. Some of these changes, but by no means all, could be attributed to enzymatic action.

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CHARACTERISTICS OF ELECTRON-IRRADIATED MEATS STORED AT REFRIGERATOR TEMPERATURES

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Although data concerning the properties of irradiated foods have been published, little information is available concerning the characteristics of such foods held for long storage periods. Meat and meat products in the raw, cooked, and cured states, processed by high energy electron irradiation, were stored over a period of 5 years. Physical and organoleptical properties are reported for foods stored in the manner described.

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SURVEY OF THE GROSS EFFECTS OF IRRADIATION ON SELECTED FOODS

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Selected ration components have been irradiated at the gamma facilities of the Materials Testing Reactor, Idaho Falls, Idaho and at the University of Michigan. They have been evaluated for preference to determine the gross effects of irradiation. The variables investigated included total dose, dose rate (flux), replication, and oxygen or vacuum packing.

The flavors of most of the foods tested were altered and the degree of change has been tabulated.

Total dose, in general, has been shown to develop significant differences between the unirradiated controls and samples treated in the range of 10,000–3,000,000 rep. The more intense the irradiation, the more extensive was the change in over-all preference. Variations in flux, within the limits attainable at the MTR, and replication can be considered as being insignificant. The presence or absence of oxygen introduces a significant difference in certain products but not in others.

In view of the possibility that some of the deleterious effects caused by sterilizing doses might be avoided by processing with dosages considerably below the sterilization level, this survey also considered radio pasteurization doses of radiation.

Certain foods have been found to be highly radio-resistant. They were unaffected by the irradiation treatment administered. Others were moderately affected, and several were drastically altered.

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OBJECTIVE TESTS TO MEASURE ADVERSE CHANGES IN STORED FROZEN VEGETABLES

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Adverse changes in the quality of frozen vegetables that occur during storage, particularly at temperatures above 0° F., are the result of chemical and physical changes that occur during the storage period. If there is sufficient understanding of the changes that are taking place, they can be used to determine by objective measurement the past history of the frozen product, its present quality, and its residual storage life.

Analytical procedures designed to determine the residual amount of a single constituent are not adequate as an index of quality unless information is also available as to the original amount of this constituent present in the freshly processed material. For frozen vegetables distributed in commercial channels, it is not practicable to obtain the latter type of information.

By the use of chemical changes, in which it is possible not only to measure the degradation of a single constituent but also its degradation products, it is possible to evaluate quality of a frozen vegetable without knowing the initial content of the constituent. Some changes of this nature are discussed including degradation of chlorophyll to pheophytin and reduced ascorbic acid to dehydroascorbic acid and diketogulonic acid.

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THAWING RATES OF PRECOOKED FROZEN MEALS IN COMMERCIAL SHIPPING CONTAINERS

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During shipment and handling, precooked frozen meals occasionally encounter thawing conditions which could lead to deterioration. Continuous maintenance of the foods at temperatures near 0° F., and the use of suitable time-temperature devices to indicate improper conditions of storage, would avoid such losses in quality. Because information on the thawing rates of these meals was lacking, investigations were undertaken to provide such data. Heat penetration measurements on precooked frozen meals (Swiss steak trays and chicken pot pie casseroles) were conducted by means of a calibrated 12-point recording potentiometer at ambient air temperatures of 100° F. (90% R.H.), 74° F. (45% R.H.), and 54° F. (85% R.H.). The meals were packed in single shipping containers and in transporter cases, 4 containers per case. Temperature gradients were found in various regions of these test cartons as the foods thawed. Rates of defrosting were related to the mass and surface area of the package. The most rapid rate of thawing of the frozen foods occurred within the top corner area of the cartons, which would be the logical place to locate a thawing indicator, while the slowest rate of defrosting took place in the center and adjacent areas. Refrigeration life of the meals was significantly extended by (1) packing the cases with dry ice, (2) enlarging the size of the package by enclosing 4 shipping containers as a unit in a transporter case, and (3) improving the insulating quality of the packaging materials. Data are presented to show the influence of these factors on heat penetration.

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STUDIES ON THE MICROBIOLOGICAL QUALITY OF PRECOOKED FROZEN MEALS

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Sanitation and quality control standards needed for the production of precooked frozen meals by a rapidly expanding industry are discussed. Survey data are presented on the microbiological quality of meals produced commercially under military specification for use by the U. S. Air Forces. At present, bacteriological standards established for this specification include a standard plate count maximum of 100,000 organisms per gram and a coliform plate count of less than 10 organisms per gram. Comparison is made with a limited number of similar products available commercially. Additional data are included on qualitative analyses for the presence of staphylococci, enterococci and *Salmonella*. Also reported are two plant studies of the production of precooked frozen meals for military procurements in which samples were taken at various stages throughout the processing from raw materials to the finished product. With plant sanitation under continuous inspection by the U. S. Veterinary Corps and the U. S. Department of Agriculture, the quality assurance provisions of the specification were met in over 90% of the production.

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THE INFLUENCE OF VINING ON THE DEVELOPMENT OF OFF-FLAVOR IN FROZEN RAW PEAS

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Development of off-flavor in peas frozen raw after vining, frozen raw in the pods, and frozen blanched after vining is reported. Results indicate that a slower development of off-flavor takes place in the peas held in storage at 0° F. in the pods than in the vined peas from the same lot. The peas in the pod are slightly higher in total sugars after storage, but the lipids extracted from them show a very large increase in peroxides. It is postulated that the peroxides accumulate without acting on other compounds. This could account for the more slowly developing off-flavor.

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TEXTURE STABILITY OF THICKENED PRECOOKED FROZEN FOODS AS INFLUENCED BY COMPOSITION AND STORAGE CONDITIONS

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The influence of constant and fluctuating storage temperature in the range encountered in normal commercial distribution has been determined for precooked frozen foods containing egg, starchy thickening agents, or a combination of thickening agents. The problem encountered in freezing of foods containing these ingredients is the curdled appearance and liquid separation found when they are thawed. This defect seriously affects the accept-

ability of the products, particularly the thickened desserts that are not reheated before serving.

Test products such as thickened sauces and desserts have been selected to include those having large differences in texture stability. The least stable product selected for testing shows no change in texture after 2 months at 0° F., and the most stable shows no change for approximately a year at 0° F. Even the most stable of the test products is stable for only very short periods at 10° F., but the stability of all of them is greatly increased at −10° F. Fluctuating storage temperature in the range 10° to −10° F. is considerably more damaging than the constant temperature of 0° F. The results of stability tests on these selected products are indicative of the stability of similar products under comparable storage conditions.

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FREEZING SWEET POTATOES

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In an effort to extend the year-round use of sweet potatoes as a vegetable, in desserts, and in meat combinations, it was found that freezing was an excellent method of preservation. Experiments showed that they can be satisfactorily preserved for 2 years or more by freezing (a) baked, whole, either peeled or unpeeled, (b) sliced, blanched and covered with syrup, or (c) precooked and mashed or puréed. As a rule jumbo potatoes were suitable only for purée or mashed potatoes, large or medium size potatoes were suitable for either purée or slicing; and medium or small size potatoes were suitable for purée, slicing or baking. Porto Rico or other highly flavored moist-type sweet potatoes were best for baking; Jersey or dry-type potatoes were best for slicing, whereas any good table variety was suitable for purée. In some varieties as high as 50% corn syrup replacement was preferred to straight sucrose.

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SELECTIVE FREEZING—A UNIT OPERATION FOR THE FOOD INDUSTRIES

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One cannot view the food industries without being struck with the need for developments in the operations of food peeling, skinning, sorting, inspecting, trimming, etc.—operations generally performed with hand labor. In many instances, the food product being processed is delicate to handle (ripe, freestone peaches), small in size (peas and beans), irregularly shaped (poultry), or, the food item has some inherent characteristic which must be overcome if the undesirable matter is to be removed from the product (skin from frankfurters, silk from corn, vein from shrimp, skin and scales from fish, etc.).

Moist objects will freeze to a clean, refrigerated metal surface. The selective freezing of moist contaminants of foods gives promise to substitute this principle for labors generally performed by hand. Applications of this principle to the food and allied industries appear widespread. A number are discussed.

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NUTRIENT COMPOSITION OF FROZEN FRUITS, JUICES AND VEGETABLES

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An informal presentation of recent observations pertinent to these frozen products.

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CONSOLIDATING THE FOOD RESEARCH RESOURCES OF THE DEPARTMENT OF DEFENSE THROUGH INTRA-SERVICE COORDINATION

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A highly practical purpose motivates military food research and development. Rations for soldier, sailor, or airman must be related to the tactical activities and logistical plans of each Service, to their supply facilities, and to food preparation and service equipment employed on a variety of transport media. Feeding men on an arctic trail, in flight on a bomber, or on a prolonged submarine voyage offers new challenges and does not permit full reliance upon former military feeding concepts no matter how successful. Neither does it always permit awaiting commercial food developments. It requires being aware of, joining the research on, and vigorously exploiting every new food development of potential future usefulness to the Services. It is for this reason that the radiation preservation of foods has been given high priority in the program of the Quartermaster Food and Container Institute. Advances being made in more conventional modes of preservation—heat processing, freezing, and dehydration—are not, however, being by-passed.

The American public is entitled to a progress report on Armed Forces food research and development as of 1956. In line with this thought we shall seek to show (1) that there is in running order, a well-established coordination system for implementing the assignment to the Department of the Army of primary responsibility for food research and development for the Armed Forces, (2) that our projects are directed not toward the problems of the last war but toward the anticipated needs of a possible "next war," (3) that the Air Force and Navy are profitably at work on food and feeding problems of concern in their operations, (4) that training in subsistence handling, food services, and ration management is coordinated with the needs of the Armed Forces and with recent developments in the food industries, and (5) that nutritional problems paralleling new food preservation developments are under exhaustive study. In short, an effective consolidation of the food research resources of the Department of Defense has been achieved.

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KEY OBJECTIVES IN FEEDING OUR FIGHTING FORCES

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Most people—certainly most food technologists— are familiar with the objectives of food research and development for the Armed Forces. It is not the purpose of this paper to recite these objectives one by one—a tiresome procedure. The purpose is to indicate how such familiar objectives as high stability, convenience of use, nutritional adequacy, and taste appeal relate to the military conditions of today—and tomorrow. This is a vital business, adjusting foods to new and ever-changing military needs. Full realization of this fact, unfortunately, never comes until we are at war, confronted by new needs, new dilemmas, and new problems. In the military trends of today we see foreshadowed (1) an increased need to streamline our feeding systems and (2) to remove from men engaged in combat as much of the handling, warehousing, and preparation of foods as is humanly possible. These tasks must be put back of the lines where they can be better and perhaps more economically handled.

The business of surviving atomic warfare, of getting out of an area of disaster without waste motion and moving into a position of defense will require bold planning—the development, perhaps, of something akin to "push button" ration systems and such new rations as "instant" dehydrated or otherwise preserved meals, packaged in lightweight containers with features permitting "instant" consumption. Fresh-tasting foods—derived perhaps from such new processing techniques as radiation—are needed. Packaged foods must be capable of being "bounced around"—as might be the case in aerial delivery, a medium and method of supply that may largely supplant conventional types of delivery.

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NUTRITIONAL ASPECTS OF AIR FORCE FEEDING

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The Air Force Food Service Program has as its ultimate goal the accomplishment and maintenance of a high level of health and maximum efficiency among its flight personnel and ground forces. An effort is made to indicate how physiological characteristics of personnel are translated into nutritional requirements. Recognition is given to extremes in climate, conditions of environmental stress, and the adverse psychological effects produced by certain Air Force assignments. The significance of food acceptability is related to morale and nutritional status. The close coordination required with research activities, particularly, the Aero Medical Laboratory, representatives of the Air Surgeon, flight operations personnel, and those concerned with aircrew effectiveness programs, is described. When special nutritional re-

quirements for a particular group exist, special authority to exceed cost limitations is obtained. As a result of nutritional requirements food service policies are formulated and feeding programs are planned. These in turn are implemented by the various members of the food service team, namely, the dietitian, the home economist, and technicians in the area of production and management.

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NEW FOODS AT ALTITUDE

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In recent years industrial research and development have been directed toward "ready to eat" and "brown and serve" type foods. This has been advantageous to the Air Force in coping with problems of in-flight feeding. Limitations of weight, space, and power aboard aircraft restrict the installation and use of food servicing equipment. For in-flight feeding, the place of preparation of food needs to be separated from the place of consumption. Meals must be prepared in advance and ready for consumption without the presence of food service personnel.

The first widely-used method of feeding aboard bomber and transport type aircraft was a sandwich meal. Later, a packet of canned foods was developed. Specially designed ovens were provided on some aircraft for heating the meat in this packet. Precooked frozen meals were next developed and are utilized on aircraft which can be equipped with ovens and refrigerators.

With the advent of high-altitude flying the problems of in-flight feeding have become more difficult. Limitations of weight, space, and power are accentuated. Crew compartments are crowded with flying instruments and controls. The pilot is heavily clothed and must wear oxygen equipment. These restrictions imposed upon the pilot affect food consumption. For these situations food packets which contain liquids and bite-sized foods are being developed. Such development requires all food items to possess, (1) suitability for specific flight situations, (2) stability for long periods of time under adverse conditions, (3) acceptability in flight and (4) nutritive value which will insure a high degree of combat efficiency.

A basic research program is in progress which is important to future development of foods to be used in flight. This program includes such studies as: Effects of Nutrients on Aircrew Performance; the Cause and Alleviation of Gas Pains; The Effects and Prevention of Dehydration; and the Effects of Aircraft Environment on the Acceptability of Foods.

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METHODS TO EXTEND STORAGE OF FRESH VEGETABLES ABOARD SHIPS OF U. S. NAVY

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Ration duration is a continuing problem in the Navy. New long-range naval craft have heightened the demands for longer shelf life.

Methods of extending the storage life of fresh salad type vegetables on ships were studied. Such products have obvious nutritional advantages.

The following are representative of the results obtained. About 70% of the cabbage stored at 32° or 38° F. remained usable after 8 weeks. Quality was best at 32° F. Celery kept longer at 32° F. than at 38° or 45°. After 8 weeks, more celery was usable at 32° than at 38° F. None was edible after 6 weeks at 45°. Polyethylene bags or crate liners increased the storage life at 32° and 38° F. Lettuce trimmed of outside wrapper leaves before storage kept better for 6 weeks at 32° F. than at 38° or 45°. At 45° no usable lettuce remained after 6 weeks' storage. A larger percentage remained usable if trimmed of wrapper leaves before storage. Polyethylene bags or crate liners increased the storage life.

In general the tests demonstrated that cabbage, celery, and lettuce retained better quality and are available longer at 32° F. than at the higher temperatures now used on ships. Tests showed that tomatoes could be kept up to 6 weeks if loaded at a mature-green stage, kept at 55° to 65° F. while ripening, and then stored at 32° or 38° F. until used. Although the tomatoes would be available longer if ripened at 55°, they would have the best quality if ripened at 65° F. Ripened tomatoes kept better at 32° than at 38° F., but in either case they must be used immediately after storage.

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QUARTERMASTER SUBSISTENCE TRAINING KEEPS PACE WITH FOOD INDUSTRY ADVANCES

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The Quartermaster Subsistence School, an important element of the Quartermaster Training Command, greatly assists through its 24 weeks of intensive instructions in obtaining for the Military full value for every subsistence dollar expended. It furnishes a continuous supply of officers trained in proper methods of planning, procuring, storing, and distributing food under peace and wartime conditions. This streamlined course of instruction covers essential background in the various commodity groups—meats, vegetables, cereal products, etc.—procurement procedures, subsistence logistics, nutrition, food services, food packaging, operational rations, subsistence marketing, and subsistence fund management. Officer students study the latest advances in food research and engineering and in a system of field trips study processing at first hand within food plants in the Chicago area. The food and container industries have been extremely generous in opening their plants for this laboratory type of education. In addition they have furnished guide-instructors to describe the industrial point of view and industrial practices. Because of his detailed classroom instruction the QM Subsistence School officer student is fully prepared to understand what is demonstrated at the plant level. Great value of this course is that it keeps the Military food system abreast of food industry progress.

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IMPACT OF RADIATION PRESERVATION OF FOODS ON MILITARY FEEDING

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The radiation preservation of food promises significant military benefits. These benefits extend beyond the mere consideration of food processing and fit into the broad concepts of the President's Atoms for Peace Program.

The studies to be discussed here concern themselves with two aspects of the general problem: (a) the assessment of the relative acceptability of various foods exposed to ionizing radiation in terms of length of storage, and (b) the assessment of the effect of length of storage on certain physical characteristics.

In relating these particular studies to the broader problems of military feeding the following topics will be given consideration: (a) the impact of this type of food preservation on the military logistics system, including reduced handling, decreased refrigeration, decreased maintenance support, and direct reduction in food losses; (b) improvement in health and morale including increased variety in foods considered for use in combat feeding, wider distribution of perishables, and control of certain food-borne diseases; (c) the relative importance of enzymes in storage.

These studies are not designed to gather detailed information on any one facet of the two general problems but rather are exploratory in design to determine which commodities and processing techniques may be most promising. Particularly this effort should delineate areas and commodities on which more intensive investigations might best be placed.

These studies also may be helpful to other workers in the field, especially those who contemplate long-range feeding studies such as those being conducted presently under contract for the Army Medical Service, Office of The Surgeon General.

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TIME-TEMPERATURE TOLERANCE OF FROZEN CONCENTRATED ORANGE JUICE

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Nine lots of commercial California frozen orange concentrate were subjected to cumulative time-temperature storage patterns simulating actual deviations from 0° F. encountered by frozen concentrates from their time of manufacture to final consumption. Four of the 9 lots had been heat-treated to stabilize against cloud loss. Samples were removed at the beginning and end of each temperature cycle and analyzed for changes in flavor, cloud,

and other chemical or physical properties which might reflect loss of quality.

Loss of cloud was found to be the most serious quality change on exposure of frozen orange concentrates to elevated temperatures, and it appeared sooner than detectable flavor changes. In those concentrates which had been heat-stabilized, cloud loss occurred before flavor changes were detected. No cloud loss occurred in any of the lots held at a constant temperature of 0° F. for 12 months or longer.

The flavor of frozen orange concentrate was found to be relatively stable, and was retained at all but the extreme time-temperature exposures.

The effects of time-temperature exposures were found to be cumulative. This indicated that although a change in cloud or flavor may not be evident in concentrates exposed to adverse temperatures, these concentrates will have undergone latent changes. When a number of temperature anomalies cumulate, cloud loss and flavor changes will result.

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CLOUD STABILITY OF FROZEN SUPER-CONCENTRATED CITRUS JUICES

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Previous studies have shown that frozen superconcentrated citrus juices of 5-, 6-, and 7-fold concentration possess superior cloud and flavor stability at constant storage temperatures when compared with commercial 4-fold frozen concentrates.

Further studies have been completed on the cloud and flavor stability of heated and unheated frozen superconcentrated orange juices stored at simulated fluctuating time-temperature conditions as compared with commercial 4-fold heated and unheated concentrates stored under similar conditions. Results verified previous findings that unheated superconcentrated orange juice had a higher degree of cloud stability under fluctuating storage temperatures than did the unheated 4-fold products.

Work was undertaken to determine why superconcentrated orange juice possesses an enhanced cloud stability. Results have shown that, to a large extent, cloud stability is a function of the concentration of sugar and citrate at each fold. Addition of sugar and citrate to 4-fold orange concentrate to simulate the concentration of these substances in superconcentrates will bring about an enhanced cloud stability in the 4-fold product equal to that obtained in the superconcentrated product. The entire characteristic curve of cloud stability versus concentration can be reproduced in single-strength orange juice by adding levels of sugar and citrate corresponding to higher concentrations of the juice.

The mechanism of the activation and inhibition of cloud loss by varying concentrations of sugar and citrate is unknown.

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STABILITY OF FROZEN CONCENTRATED ORANGE JUICE. III. THE EFFECT OF HEAT TREATMENTS IN THE PRODUCTION AND STABILITY OF HIGH-BRIX FROZEN CONCENTRATES

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A study was made of the cloud stability, flavor, and pectinesterase activity of unheated and heat-stabilized frozen orange juice concentrates of 42° and 58.5° Brix. Valencia orange juice was heated in 0.8 seconds to temperatures of 150° and 180° F. in a small tube heat exchanger, held at the respective temperatures for 5 seconds, cooled to 75° F. in 3 seconds, concentrated to 55° or 68° Brix in a falling film evaporator and cut back with unheated juice to either 42° or 58.5° Brix. Among unheated controls the 58.5° Brix concentrates were more stable than those of 42° Brix. Heat treatment at 150° F. in the preparation of 42° Brix concentrate resulted in cloud stability approximately equal to unheated 58.5° Brix controls. Heat treatment at 150° F. or higher in the preparation of 58.5 Brix concentrates gave complete stability at 40° F. for the full 42-day observation period. When equal amounts of heat treated (150° F.) and unheated 68° Brix concentrates were mixed and cut back with unheated juice to 58.5° Brix, the products were completely cloud stable for the 42 days of observation. No significant difference in flavor between the 42° Brix and 58.5° Brix concentrates was found.

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THE "COF" EFFECT IN CITRUS PRODUCTS

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The "COF" effect in frozen citrus products has a dual character, comprising a "tallowy mouth-feel" and a "castor-oil" odor. It appears that a propensity toward development of these effects is especially characteristic of early-harvested grapefruit and of early varieties of orange. A certain period of frozen storage is required for these effects to appear; however, more protracted storage tends to bring about their disappearance. Examination of replicate samples at any given time often shows extreme can-to-can variation in intensity of these effects; this may be due in part to unexplained variations in rates of their appearance and disappearance. In general, the odor disappears before the tallowiness does, and this is part of the evidence that the two effects are due to distinct but correlated causes. Other workers have obtained evidence to show that when the propensity toward these effects exists, the intensity of the effects generally may be increased by aeration of the material before freezing.

The present work affords some basis for the suggestion that these effects are due to phenomena pertaining to the biosynthesis of fats from sugars. The tallowiness can be well reproduced by dispersing in the citrus product some of the free fatty acids obtained by hydrolysis of citrus fats (for convenience, grapefruit seed-oil was used). Addition of the oil itself does not confer tallowiness. It is suggested that these free fatty acids are present in the frozen product, not because some of the original lipid has been hydrolyzed during storage, but because the natural processes, whereby a citrus fruit produces fat from sugars, continue to be operative during frozen storage, and in large measure these processes are interrupted at the free fatty acid stage under such conditions. An interesting parallel with certain recently-established facts concerning the behavior of other food products in frozen storage may be interpreted as corroborative of this suggestion. The actual production of fatty acid from sugar is a drastic reduction rather than an oxidation, but it is known that in nature this process must be energized by the oxidation of other sugar to CO_2. It is known that this physiological process is most active in immature fruit.

It has been found that a good facsimile of the "castor oil" odor can be produced by a certain non-oxidative treatment of a purified and odorless grapefruit seed-oil. This remarkable fact has made it possible to investigate the odor under other than field conditions. The purpose of this part of the investigation has been, not only to gain further information as to the mechanism of these effects, but also to search for an objective analytical test sensitive enough to supplement the sensitive but aggravatingly variable organoleptic perceptions which so far have been the only feasible means of investigating these flavor effects in the field. This is important, because it is believed that practical means of control are most likely to be found by field investigations of physiological maturity.

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OXIDIZED FLAVORS IN FROZEN CITRUS CONCENTRATES

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The development of off-flavors, described as similar to cardboard, tallow or castor oil, in frozen citrus concentrates has become a problem of some significance. Reproduction of these undesirable off-flavors has been accomplished by the incorporation of air into frozen citrus concentrate prior to freezing; therefore, it is believed that these off-flavors are the result of oxidation processes that will occur at 0° F. or below, since the products were of good quality when packed. The nature of the problem appears similar to the occurrence of oxidized flavors in dairy products, such as milk and ice cream.

Results were obtained from the examination of 175 experimental packs and over 400 commercial samples of frozen citrus concentrates. Different varieties of oranges, tangerines, and grapefruit were used. Oxidized flavors were found to occur during frozen storage in grapefruit concentrates and also most frequently in orange concentrates produced chiefly from early or mid-season oranges. The addition of peel oil to concentrate

reduced the possibility of detection of oxidized flavors, should such off-flavors develop. Before means of control may be suggested, additional data and information are needed concerning the causes of the development of these flavor defects.

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RATE OF GROWTH OF POTENTIAL SPOILAGE BACTERIA IN ORANGE JUICE

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Certain bacteria will grow in orange juice while it is being concentrated in commercial evaporators and, if growth continues for a sufficient period of time, spoilage of juice or concentrate will result. Purpose of this study was to determine the effect of degree of concentration, pH, temperature, and oxygen tension on the rate of growth of potential spoilage bacteria in orange juice to provide a better understanding of conditions that would influence the growth of these organisms during the production of orange concentrate.

Test organisms used were *Lactobacillus brevis, Lactobacillus plantarum, Leuconostoc mesenteroides,* and an *Achromobacter* species. Rates of growth of these organisms were determined using orange juice of 10°, 20°, and 30° Brix; juices having pH 3.5 or 4.0 were also used. Growth rates at 60°, 70°, and 80° F. were obtained and also when the bacteria were incubated under both aerobic and anaerobic conditions.

The rate of growth of the bacteria studied, except *L. mesenteroides,* increased when the pH of the juice or the temperature of incubation increased or when the degree of concentration decreased. *L. mesenteroides* grew more rapidly in 20° Brix orange juice than in juice of 10° or 30° Brix; also more rapidly at 70° F. than at 80° F. A decrease in the oxygen tension had little effect on the rate of growth of the organisms studied.

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AMINO ACID CHANGES DURING THE BROWNING OF ORANGE JUICE

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Qualitative changes in the amino acid composition of Valencia orange juice exposed to air in presence and absence of suspended chromatophores and pulp particles were observed after four years' storage at room temperature. Aliquots of the juice were chromatographed initially, after 2 months, and after 4 years. In the clear serum free of orange protein (present in chromatophores) lysine disappeared, concentration of glutamic acid was noticeably decreased, and other amino acids were unchanged. Similar results were obtained with the juice stored in presence of chromatophores. Apparent glutamic acid and lysine were involved in the browning reaction.

In model system tests, however, in presence of citrate buffer, ascorbic acid was the most reactive component and the amino acids added (alanine, asparagine, glycine glutamic acid and lysine), or the sugars added (glucose or fructose) either alone or together did not contribute greatly to total browning. In single strength orange juice amino acid interaction apparently is a secondary phenomenon if it occurs.

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QUANTITATIVE ASPECTS OF STRAWBERRY PIGMENT DEGRADATION

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Anthocyanin pigments of fruits degrade during heating and storage of fruit preserves. In this study, the major anthocyanin of strawberries was prepared in crystalline form, using paper chromatography. The degradation of the pure pigment in the absence of oxygen, in citrate buffer at pH 2.0 and 3.4, followed first order reaction rates over the temperature range from 45° C. to 110° C. Straight and parallel line thermal destruction-time rates were obtained under the same conditions. The presence of oxygen or ascorbic acid accelerated the pigment degradation. These two factors combined caused more destruction of pigment than the sum of their single effects. Metallic ions or 5-hydroxymethyl-2-furfural also accelerated the degradation of pigment. Destruction of the ascorbic acid of strawberry juice by ascorbic acid oxidase resulted in higher pigment retention. High temperature-short time heat treatment was found less destructive to the pigment than conventional treatment when the required heat process for a *Penicillium* organism was applied. Nineteen different additives were tested for their effect in protecting the pigment; only thiourea, propyl gallate and quercetin showed some favorable effects.

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THE ROLE OF ENZYMES IN FOOD FLAVORS

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The science of food processing is today largely concerned with problems regarding flavor. These problems fall roughly into three groups, depending upon the type of food and the food processor's objectives: (1) to present to the consumer food which is instantly recognizable as fresh (2) to prepare food so that it has the flavor of freshly prepared fresh food and (3) to prepare food which conforms to the consumer's notions of desirable flavor.

Since the flavor of fresh foods is due to chemical substances metabolized by the living plant or animal, it is an obvious but nevertheless often-overlooked fact that such flavors are formed by enzyme action.

Thus, in the study of food products it is important to determine what part the flavors of the fresh food (that is, the enzymatically produced flavors) play in the desirable flavors of the food or food products as presented to the consumer. The flavor of processed foods may be compounded of the fresh flavor which has persisted through processing, the flavors which come from conversion of the fresh flavors originally present, and the flavors which arise during processing.

The role of enzymes in the spoilage of foods and in the formation of off-flavors will not be considered. There will be presented here a discussion on the enzymatic agency in fresh flavor formation, and the possible utilization of this knowledge.

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RECENT DEVELOPMENTS IN FRUIT AND VEGETABLE POWDER TECHNOLOGY

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The development of stable food powders has been a long-sought goal of research workers. While many foods in powder form have been on the market for years, only recently have processes become available for production of whole fruit and vegetable juice powders that meet the exacting requirements of flavor stability during the desired storage life.

Work on vacuum drying at the Western Utilization Research Branch has contributed materially to the successful production of these powders. The fruit or vegetable concentrate puffs during drying under vacuum, and the product has an open structure so that it reconstitutes readily. Some powders, such as tomato or pineapple, may require no flavor fortification, but most fruit powders are improved with flavor fortification. Citrus powders, such as orange, are fortified by the addition of a high quality cold-pressed orange oil, sealed in a solid carrier. Some powders may be fortified by the addition of volatile flavoring constituents where recovery is feasible from the original juice. In laboratory experiments, flavoring constituents have been concentrated, incorporated in an edible oil, then added to a suitable solid carrier. Recent research has shown that certain amorphous sugars may prove superior carriers for flavoring materials.

Stability of the powder is improved by use of an in-package desiccant which brings the powder to a moisture level not practically attainable during the drying process, and maintains the powder at this low moisture level during storage.

Puff-drying has been used successfully to produce high quality powders from tomato, orange, lemon, grapefruit, lemonade, and pineapple. All of these show considerable promise for commercial exploitation. Orange, grapefruit, tomato, and lemonade powders are already available on the market, or ready for test marketing.

Other processes for powder production, especially spray drying, are still being studied and may be competitive with puff drying when fully developed.

While most powders will find a market primarily in beverages, they will probably also find use in the remanufacturing trade, *e.g.*, citrus powders in bakery goods mixes and tomato powder in dry soup mixes, catsup, sauces, and pastes.

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A STUDY OF COMMERCIAL JUICE APPLES OF THE PACIFIC NORTHWEST

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Commercial juice apples from 3 main producing areas of the Pacific Northwest were sampled periodically from September 30, 1954, to March 1, 1955, to determine the range of quality available to processors. Soluble solids were found to be a good index of the flavor of juices prepared from all varieties, regardless of season or area from which the fruit was drawn. Higher soluble solids were almost always associated with better flavor. The soluble solids content varied considerably within each variety throughout the pressing season, but low soluble solids and high starch content were characteristic of Delicious apple samples taken during October. Flavors associated with overmaturity were not encountered.

Post-harvest ripening of Delicious apples to improve flavor was found to be impractical after delivery to the processing plant because severe bruising in this grade fruit resulted in heavy losses from decay. The flavor of juice was not appreciably affected by moderate bruising even when the fruit was ripened 6 weeks after bruising

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DEHYDROCANNED APPLES

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Dehydrocanned apple pie stock is a new product which consists of apple slices dried to half their original weight and subsequently processed. The product is of good quality and the process results in savings in packaging and could result in transportation savings because of the reduced weight and increased bulk density of the products.

The process consists of immersing for 2 minutes fresh apple slices in 1.0% sodium chloride solution containing 1.0% citric acid. No surface browning occurs during processing despite the fact that no sulfur dioxide is used and the enzymes are still active. Drying can be done in any of several types of atmospheric driers with air temperatures of about 160° F. and piece temperature below 120° F. When the pieces are dried to one half their fresh weight, they are steam blanched under controlled conditions of time and temperature which inactivate enzymes responsible for browning. The texture of the fruit is not impaired by this treatment and the slices maintain a porous opaque appearance. The blanched fruit is hot-filled into cans, vacuum-sealed, and heat-processed. Results of storage stability tests at 34°, 70°, 90°, and 100° F. are reported.

Varieties such as Winesap, Rome Beauty, and Newtown Pippin were used to produce the dehydrocanned apple pie stock.

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A QUALITY CONTROL PROGRAM FOR THE PROCESSING OF SWEET CORN

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The variability that exists in food materials has been a deterrent in the application of statistical quality control charts to food manufacturing process. While it is recognized that food products are more variable than the manufactured articles of other industries, this in itself does not exclude the use of control charts. It merely indicates that control limits must be wide and must be adjusted to the situation.

Research at the University of Maryland and other institutions had provided a number of tools with which quality factors in sweet corn might be readily evaluated objectively; thus, the necessity of developing a comprehensive program for the application of this knowledge to actual production problems seemed evident. Quality control charts were therefore instituted in several sweet corn producing plants to accomplish this objective. Both cream style and whole kernel packs were represented in the study.

Control stations were established at the receiving, in-plant, and finished product points of production. Such factors as maturity, defects, percent insect infestation, and percent cut-off were charted. The relationships between raw product, in-plant, and finished product controls are discussed with the aid of the statistical control charts. Adjustment of limits is suggested to make the charts more useful and informative in special situations.

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PROBLEMS INVOLVED IN THE PRE-PEELING AND PACKAGING OF SWEET POTATOES

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The main changes occurring in pre-peeled and packaged sweet potatoes were found to be the loss of ascorbic acid, changes in the carbohydrates, toughening of the outer anatomical layers and the loss of flavor during storage of the product. Several chemical treatments which in previous experiments showed to be of value in preventing darkening and spoilage of pre-peeled sweet potatoes were used in this study to determine what effect they had upon these changes. After treatment, samples were stored at 35°, 40°, 55°, and 70° F. Lower temperatures were more satisfactory for preserving pre-peeled sweet potatoes, not only from the standpoint of flavor and storage life, but also because toughening of the outer layers was less prevalent. An analysis of the samples showed that there was a decrease in the ascorbic acid content during storage, especially in the control sample. Also, there was an increase in the reducing sugars and a decrease in the starch content during lye-peeling and in storage.

Morphological studies were made of sections of the outer layers of the pre-peeled samples in conjunction with the other tests in an attempt to determine the cause of toughening. There was an absence of starch grains in the corticle layer of lye-peeled sweet potatoes compared to the hand-peeled. The hand-peeled samples that were packaged in moisture-proof bags did not develop toughening as rapidly. Therefore, since lye-peeled samples show no starch grains in the outer layer, it may indicate that gelatinized starch is party responsible for the toughening.

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PAPER WITHDRAWN

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POLYPHENOLIC CONTENT AND ENZYMATIC ACTIVITY IN TWO VARIETIES OF POTATOES. I. PRELIMINARY REPORT

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Ontario and Pontiac potatoes, representing susceptible and non-susceptible varieties to blackening, were examined qualitatively and quantitatively for polyphenolic content at three levels of maturity; cytochrome oxidase and polyphenolase activities were determined by oxygen uptake measurements.

Using butanol-acetic acid-water (4:1:5) solvent system and ascending paper chromatography, four spots were isolated from purified acetone extracts having R_f values of 0.50, 0.63, 0.74 and 0.98. There was no qualitative difference between the varieties except for the water soluble pink pigment of the Pontiac variety. All of the above substances were repressed by use of borate paper which complexes the polyphenols. By use of bromphenol blue, quinic acid was shown to be present in the water soluble fraction of both purified extracts.

The polyphenolic content of the two varieties at three levels of maturity was determined by employing the methods of Arnow, and Rosenblatt and Peluso. The second harvest portrayed the highest polyphenolic content for both varieties, and each harvest of Ontario potatoes contained greater amounts of these constituents than the Pontiac variety.

Spraying paper chromatograms with potato enzyme preparations resulted in the browning of two of the Ontario spots and three of the Pontiac spots.

The cytochrome oxidase activity in both varieties of potatoes, as measured by oxygen uptake, decreased by more than 30%

from the first to the third date of harvest. The polyphenolase activity in the two varieties remained nearly constant for the three harvest dates.

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EFFECT OF 2,4,5-TRICHLOROPHENOXYACETIC ACID SPRAY ON ORGANIC ACIDS AND PECTIN CONTENT OF CANNED APRICOTS

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Blenheim apricot trees in the Winters and Santa Clara districts of California were sprayed with 2,4,5-trichlorophenoxyacetic acid at the beginning of the pit-hardening period to stimulate growth. The apricots were harvested at various stages of maturity and canned in 40° Brix sucrose syrup according to commercial procedure. The canned products were analyzed for malic and citric acid contents by silica-gel column chromatography, and for pectic materials by the carbozole method.

Results indicate malic acid is the dominating organic acid in apricots, although a smaller amount of citric acid is also present. Both malic and citric acid contents decrease as the fruits mature on the tree. When the pressure test of the fresh fruit drops to 3 pounds or below, the rate of decrease of malic acid in the 2,4,5-T sprayed samples was more rapid than in the control samples. The importance of organic acid metabolism to maturation and quality of apricots is discussed. The effect of maturity of the fresh fruit on pectin, drained weight, serum viscosity and quality of the canned product is also considered.

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EFFECTS OF CANNING ON NEW AND FAMILIAR SWEET POTATO VARIETIES WITH PARTICULAR EMPHASIS ON BREAKDOWN AND FIRMNESS

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Loss of wholeness and firmness in the canned product has been a major problem of sweet potato canners since the industry started. Attempts in the past to control this difficulty by changes in canning techniques have not been too successful. It is common knowledge that certain varieties perform better in some areas than in others. A possible solution to the problem was sought in this work by checking the effects of canning on various sweet potato varieties that were grown and canned in this country's two climatically different areas, Maryland and Louisiana.

Portions of 11 test varieties grown in the two areas were canned when freshly dug and after two intervals of commercial storage. Samples of the canned product were examined periodically for quality up to one year from canning date. Results indicate the variety, growing conditions and storage of raw stock are all definite factors that affect the quality of the canned product. Firmness and wholeness of the canned product were affected to the greatest degree, and almost the only quality characteristics affected adversely by these factors.

While it is realized that the results of a single season's work are affected by certain physiological changes occurring in any given sweet potato variety—from year to year and from area to area due to variations in growing conditions—these findings do indicate the importance of the pre-canning handling of the raw product and give some indication of the relative performances of different varieties when canned.

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RELATIONSHIP BETWEEN CALCIUM CONTENT AND CHIPPING QUALITY OF POTATO TUBERS

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The calcium content of potato tubers of 12 varieties of potatoes proved to be a better index of chipping quality than any other measured characteristic in 1954. The following coefficients of correlation were obtained in 1954.

Calcium content vs. fat absorption of chips	0.87
Calcium content vs. color of chips	0.69
Total solids vs. fat absorption of chips	0.45
Total solids vs. color of chips	0.36

Other factors influencing the quality of potato chips included date of planting, date of digging, moisture level, and nitrogen level.

A multiple correlation coefficient of .93 was obtained between calcium content and the combined factors, *i.e.*, total solids, color value and fat absorption.

The 1955 data involving 31 varieties substantiates and confirms the 1954 results.

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STORAGE PROPERTIES OF GAMMA IRRADIATED POTATOES

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Potatoes of the Sebago and Russet variety within two months of harvest and again at the end of their natural storage life have been irradiated with doses of gamma radiation from 0 to 200,000 rep. They were then stored under a range of temperature conditions from 35° F. to 80° F., and a range of humidity conditions from 60% to 95%. Data on weight loss have been analyzed and show a dependence of weight loss on temperature, humidity, dose of irradiation, and time. The minimum dose for absolute assurance of sprout inhibition lies between 10,000 and 15,000 rep.

Respiration studies of irradiated and non-irradiated potatoes have shown that for several weeks after irradiation there is an increase in respiration in irradiated potatoes as compared to controls. Thin slices of the bud and the surrounding tissue from irradiated potatoes showed a definite increase in respiration. Whole tubers showed a definite but lesser increase in respiration.

Sprout-promoting and sprout-inhibiting hormones have been separated by paper chromatography and assayed at various periods after irradiation using the Avena technique. Reducing sugar analyses showed a marked lowering of reducing sugar content with increasing storage temperature, but no apparent dependence upon the dose of irradiation. Sucrose values increased with time of storage, but starch content showed little change. Acceptance studies by the Quartermaster Food and Container Institute showed that these potatoes when given a dose of gamma radiation as high as 200,000 rep were as acceptable as nonirradiated potatoes.

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DETECTION OF FREE RADICALS IN IRRADIATED FOOD CONSTITUENTS BY ELECTRON PARAMAGNETIC RESONANCE

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Since it is believed that many of the undesirable chemical, physical, and organoleptic changes observed in irradiated foods are due to free radical reactions, improved methods for the detection and identification of free radicals are desired. Such methods should aid in the study of the mechanism involved in their formation and subsequent interaction with food constituents. Electron paramagnetic resonance spectroscopy, which is based on unique magnetic properties of the unpaired electrons in free radicals, is a very promising, non-destructive method for the *in situ* detection of free radicals in irradiated substances. The resonance absorption of microwave energy by a substance contained in a resonant cavity and located in a strong magnetic field, results in spectral lines whose frequency, intensity, and shape can be related to the types and amounts of free radical species in the sample.

Electron paramagnetic resonance signals attributed to free radicals have been observed in irradiated proteins, carbohydrates, amino acids, and other organic food constituents. Many radiation-induced free radicals are stable indefinitely if recombination is prevented by irradiating frozen solutions at liquid nitrogen temperatures. Free radicals in irradiated powders are surprisingly stable under room temperature conditions. This paper briefly describes the electron paramagnetic resonance method and presents the results of some preliminary work on the detection and identification of free radicals in irradiated food constituents.

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STUDIES ON A RADIO-RESISTANT MICROCOCCUS

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A radio-resistant micrococcus resembling *Micrococcus roseus* and *Micrococcus rubens tetragenus* has been isolated from samples of ground beef and pork following irradiation dosages of 2 and 3×10^6 rep. Pure cultures of isolated organisms have survived extreme exposures of 6×10^6 rep on agar slopes and between 5 and 6×10^6 rep when exposed in tryptone glucose yeast extract broth which had been previously cultured for 24 hours. This order of resistance was 6 to 8 times that of *Micrococcus pyogenes* var. *aureus* and greater than that of any spore-forming bacteria tested thus far. Strains of the organism isolated from naturally contaminated unirradiated meat demonstrated the same high order of radiation resistance.

The organism is a Gram-positive, non-spore-forming, psychrophilic tetracoccus which possesses a brownish red pigment. It grows well on tryptone, glucose, yeast extract agar or broth either aerobically or anaerobically; however, aerated broth cultures produce most rapid growth.

Growth of the organism in irradiated meat was accompanied by CO_2 production and slight proteolysis in the sealed can and marked proteolysis in the opened cans. Growth occurred slowly in refrigerated samples at 41° F. (5° C.) and not at all at 133° F. (45° C.).

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EFFECTS OF GAMMA RADIATION ON THE PECTIC CONSTITUENTS OF FRUITS AND VEGETABLES

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Softening of fruits and vegetables by the action of ionizing radiations has been observed in numerous studies. The nature of this texture change indicated that it might result from the destruction of pectic materials in the tissues. This invesigation was undertaken to determine the effect of radiation on the pectic constituents of apple and carrot tissues. Gamma ray doses of 0.5×10^6, 1.0×10^6, 1.5×10^6, and 2.0×10^6 rep were administered from a CO^{60} source. Protopectin, pectin, and pectic acid fractions of the irradiated products were then compared with similar extracts from untreated controls. Results indicated that a degradation of protopectin to soluble pectins occurred as a result of irradiation. A decrease in relative viscosity of the three pectin fractions was also observed, indicating a decrease in size of the pectic molecules.

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CHEMICAL CHANGES INDUCED BY IRRADIATION OF BEEF, PORK, CHICKEN, AND FISH

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In irradiated meats, the destruction of niacin, riboflavin and vitamin E was found to be low or insignificant at the levels of gamma radiation used in preservation or sterilization. Thiamine is very sensitive to irradiation and its destruction during sterilization of meat constitutes one of the most important nutritional problems of irradiated meats. The destruction of carotenoids by ionizing radiation is a function of the oxygen lability of the carotenoid and its biochemical environment in the food. The carotenoids of salmon are destroyed to such a large extent that the application of irradiation-preservation to salmon is contraindicated. It is necessary to irradiate meats in atmospheres low in oxygen because of the development of oxidative fat rancidity as defined by production of lipid peroxides. When meat is radiated in oxygen atmospheres, there is an oxidative destruction of the hematin compounds. When meat is radiated in atmospheres of nitrogen, the oxymyoglobin formed gives radiated meat a pleasing red color.

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THE EFFECT OF IONIZING RADIATIONS ON CAROTENOID STABILITY IN TOMATOES

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The stability of carotenoids in tomatoes to ionizing radiation (Cobalt source) has been investigated. Two types of tomato were tested: (1) normal red-fruited, high in all-trans lycopene, (2) orange-fruited, high in β-carotene. The effect of dosages varying from 0.1 to 20×10^6 rep was examined. As will be observed from perusal of the data, carotenoid losses were relatively low, even at high dosages, both in air and in nitrogen. The behavior of the shrimp carotenoid was similarly studied. For comparison purposes, solutions of lycopene and β-carotene were similarly irradiated and heavy losses were observed. The absorption spectra and adsorption behavior of the major colored breakdown products of each were characterized. Five were obtained from carotene, eight from lycopene solutions. From these observations, we conclude that the state of the carotenoid *in situ* determines the stability of the carotenoid to irradiation. Tentatively, we believe the greater part of the pigment in tomatoes occurs in semi-crystalline or amorphous masses, that little is attached to protein, and consequently shows greatest stability. The shrimp carotenoid attached to protein is substantially less stable, while the carotenoid in solution shows least stability.

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RADIATION INDUCED CHANGES IN THE MATURATION OF TOMATO FRUITS

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Studies were undertaken to evaluate the changes in tomato fruits at various maturity levels as influenced by radiation treatments. Respiration rates and pigmentation processes are altered by radiation exposures. Irradiated fruits eventually overcome the initial alterations in normal maturation processes if the dosage is at levels up to 1.5 million rep. Irradiated fruits can be surface sterilized, but such treatments make the fruits more susceptible to spoilage thereafter than control specimens. A protective, gas permeable membrane is indicated to protect fruits from post-treatment infections by plant pathogens.

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THE DIACETYL TEST AS AN AID FOR QUALITY CONTROL OF CITRUS PRODUCTS

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The diacetyl test was developed for the detection of microbiological growth in orange juice during the production of orange concentrate in commercial evaporators. The diacetyl value is dependent upon the concentration of both acetyl-methylcarbinol and diacetyl in the citrus product. These substances are metabolic products of the growth of acid-tolerant bacteria, such as the *Lactobacillus* or *Leuconostoc*. Off-flavor, usually described as "buttermilk," results in a product if the diacetyl content becomes sufficiently great. Data will be presented illustrating the use of the diacetyl test as a means for preventing spoilage of orange juice during the production of orange concentrate in a commercial plant.

The effect of fruit variety and maturity on the diacetyl values found in raw citrus juices was determined for oranges, grapefruit, and tangerines. Diacetyl values for over 400 samples of commercial 42° Brix frozen orange concentrate and some commercial samples of 55°–60° Brix orange concentrate will be reported. The significance of diacetyl values in raw juice, 42° Brix and other citrus products will be discussed in relation to the occurrence and detection of off-flavors in these products.

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MICROORGANISMS OF SIGNIFICANCE IN FROZEN CITRUS PRODUCTS

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An evaluation of the significance of microorganisms found in frozen citrus concentrates is presented in relation to production practices. Coliform bacteria in citrus products are discussed with regard to incidence and methods of isolation. It is suggested that other microorganisms capable of growing in single strength, or partially reconstituted orange juice, would furnish a more logical index of sanitation in the production of frozen citrus products. Lactic acid bacteria are shown to be a major micro-biological factor in the production of poor quality in citrus products.

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GROWTH CHARACTERISTICS OF SPOILAGE ORGANISMS IN ORANGE JUICE AND CONCENTRATE

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Growth curve characteristics in orange juice and concentrate were determined for 3 different types of organisms, *Leuconostoc* species, *Lactobacillus plantarum*, and *Zygosaccharomyces vini* (a yeast), all previously implicated in product spoilage. These organisms were grown at four different temperatures ranging from 40° F. to 86° F. in 5 different concentrates ranging from 12° Brix to 58° Brix, which are inclusive of all conditions met in the production, handling, storage, and selling of orange juice and concentrate. From the 45 separate growth curves determined in these studies the following general observations were made: (1) The lag phase of microorganismal growth was independent of the growth conditions and was a function of only the nature of the inoculating culture. (2) A decrease in growth temperature from an optimum of 86° F. resulted in a decrease in the growth rate of the 3 organisms tested. (3) An increase in the degree Brix from optimums of 12° and 20° resulted in a decrease in the growth rate of the 3 organisms tested. (4) Under conditions of high Brix and low temperature, minor anomalies may occur in the growth curve characteristics. (5) Both the *Leuconostoc* species and the *Lactobacillus plantarum* strains tested did not grow at 40° F. regardless of the degree Brix and did not grow at 42° Brix regardless of the temperature. (6) With increasing degree Brix the minimum temperature at which a given organism would grow increased. (7) *Leuconostoc* species under the most favorable conditions of Brix and temperature was capable of attaining a concentration of approximately a billion organisms per ml. in 24 hours from an initial concentration of only 10,000 organisms per ml.

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BACTERIOLOGICAL FLORA IN FROZEN AND CHILLED ORANGE JUICE

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Orange juice has been reported to contain a variety of microorganisms. This investigation deals with the determination of the identity of the Gram negative rods which develop when orange juice is plated on media used for the determination of coliform organisms. The 150 Gram negative rods studied were isolated on Violet Red Bile Agar from commercial and experimental samples of orange juice. To detect *Escherichia coli*, the purified isolates were examined for gas production in the Eijkman test as modified by Perry and Hajna (*J. Bact.*, 26, 1933) and growth in borate broth under conditions described by Vaughn, Levine and Smith (*Food Research*, 16, 1951). The lack of gas formation in the Eijkman test and absence of growth in borate broth by the 150 isolates indicated that these cultures were not *Escherichia coli*. The fact that these cultures were not methyl red positive, idol positive, Voges-Proskauer negative and citrate negative may be taken as further evidence that none of these cultures were *Escherichia coli*.

The usual pure culture techniques of identification were carried out on 17 Gram negative rods isolated from one batch of orange juice. The results indicated that 5 cultures closely resembled *Aerobacter areogenes*, 4 *Escherichia freundii* 2 *Escherichia intermedium* and 1 *Serratia marcescens*. The remaining 5 cultures appeared to belong to the genus *Erwinia*.

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FACTORS TO CONSIDER CONCERNING THE OCCURRENCE OF COLIFORMS IN CITRUS PRODUCTS

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The occurrence of coliform bacteria in any food product is looked upon askance, chiefly because of the emphasis that has been placed upon their significance in water and in dairy products. Usually, the presence of coliform bacteria in citrus products is insignificant and millions of gallons of citrus juices are being consumed annually without any apparent ill effect on the health of consumers. Information will be presented so that those persons concerned with the subject of coliforms in citrus products may be better able to interpret results obtained from the microbiological examination of these products.

Coliform bacteria found in citrus processing plants in Florida have been traced to the use of over-mature or improperly washed fruit and to the presence of fruit flies. Survival of coliform organisms in citrus products depends upon variations in strains, the nature of the product, as well as the temperature and time of storage. *Escherichia coli* usually does not survive as extensively as do species of *Aerobacter*. Temperatures above 0° F. cause their extinction in less time than temperatures of 0° F. or below. The media proposed for the identification of coliform bacteria, which resemble *E. coli*, have not proved to be of much assistance in speeding up the screening tests; completed tests still are necessary if a positive identification of *E. coli* must be made. Coliform bacteria in processed citrus products, produced in clean plants using good sanitary practices, should have no more significance that that placed upon the presence of similar organisms on other raw or processed fruits and vegetables.

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CURRENT REFRIGERATION PROBLEMS OF INTEREST TO THE CITRUS INDUSTRY

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To maintain optimum quality, many foods should be cooled immediately after harvest, and kept under refrigeration until the housewife takes them from her home refrigerator to be prepared for the table. There are still gaps in this chain needing to be filled. Some of the recently-closed gaps will be discussed, touching briefly on how they have been cared for. Some new problems affecting the citrus industry which these have created will be outlined and remedies suggested.

Immediate "precooling" of harvested foods is the first step in maintaining optimum quality for the consumer. It also has a definite relation to the successful use of mechanically refrigerated railroad refrigerator cars and mechanically refrigerated trucks, now both important in the movement of foods from producer to consumer, and destined to become increasingly more important. Methods of precooling will be touched on and some of the "jokers" in their use discussed.

The mechanically refrigerated car will be described briefly for the edification of those not familiar with this new development. Its advantages and limitations will be outlined.

Refrigeration problems in the retail store, created by self-service merchandising, will be stressed. These are of vital concern to both the citrus industry and the frozen food industry. They affect the quality of fruit juice concentrates when they reach the consumer. Some readily usable corrections for these problems will be suggested.

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A CHEMICAL AND FLAVOR STUDY OF OFF-FLAVOR DUE TO ARTIFICIAL PEPPER

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Through the coordinated techniques of flavor evaluation and organic chemistry, a black pepper oleoresin of abnormal composition was found to be the source of an unexpected off-flavor that developed in a commercial product. The compound responsible for the off-flavor was isolated and characterized.

The investigation was initiated when a normally high-quality product was found to have developed flavor characteristics described as unpleasant. This change was defined and described by flavor panel evaluation. All ingredients of the product were screened by the flavor panel for off-flavor, and it was determined that a black pepper oleoresin was its direct cause. A detailed investigation of the offending oleoresin in comparison with an authentic sample of black pepper oleoresin was carried out.

The suspected oleoresin was separated by chromotographic analysis and by distillation to obtain the volatile and nonvolatile components. This separation revealed the presence of several compounds not commonly found in the natural oleoresin. Fractional distillation of the volatile oils yielded a sesquiterpene hydrocarbon ($C_{15}H_{24}$), which at a concentration of 2 p.p.m. (.0002%) exhibited the typical unpleasant flavor and aroma first noted in the product. Investigation of the nonvolatile components of the oleoresin resulted in the isolation of, in addition to piperine, a quantity of 1-cinnamoyl piperidine. Both compounds exhibit a very sharp pepper "bite" sensation. The 1-cinnamoyl piperidine, although not a common constituent of natural black pepper, apparently made no contribution to the off-flavor produced by the oleoresin.

A method is suggested for the evaluation of black pepper oleoresins from the standpoint of off-flavor factors and abnormal composition.

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CONSUMER ATTITUDES TOWARD THE USE OF IMITATION PEPPER IN ARMY MESS-HALLS

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The consequences of substituting imitation for natural pepper were studied in a field test at a large Army post. The effect of the label, "imitation," was also considered as a possible determiner of attitudes. For 6 weeks the imitation pepper was used in 10 mess-halls while 10 comparable units used natural pepper. In order to assess the label effects, the two products were deliberately mislabeled for half of each group. General food preferences were measured before and after the trial period. A sample of the soldier consumers and all mess personnel were interviewed at the end of the trial period.

Compared to the consumers and mess personnel who used natural pepper, those using the imitation product tended to consider it inferior to the kind normally used. The label on the container had little effect on the evaluation of the peppers. Only a small percentage of consumers were aware that a test of pepper had been under way. Whether a consumer believed he had been using natural pepper or imitation pepper was dependent on the actual pepper type and not on the label. Negative attitudes toward food products in general were displayed by consumers. There was no evidence that the food preferences of the consumers were affected by the type of pepper actually used, or by the labels.

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EVALUATION OF FLAVOR CHANGES DUE TO PESTICIDES—A REGIONAL APPROACH

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Flavor changes in processed fruits and vegetables caused by pesticides are due to such factors as types and concentration of pesticides, time and method of application, crop being treated (*i.e.*, root or above ground), climatic and adaphic factors, and preprocessing and processing techniques. These changes may be either deleterious to the flavor of the product or in some cases may improve flavor because of increased vigor in the plant protected from insects or diseases.

In this experiment emphasis has been given to development of a uniform standard method to measure these changes in flavor. The modified multiple comparison with standard or variables method has been used. Data from 5 experiment stations in the Northeast region using the standard method have been evaluated. Samples from the same lot of processed snap beans, squash, and apples (apple sauce) were tested in each laboratory. The cooperating Agricultural Experiment Stations are Maine, Maryland, Massachusetts, New York, and Pennsylvania.

Results of the Northeast Region standard flavor method show excellent uniformity among stations. The method is relatively simple to administer and is reasonable in material and time requirements. In 1956 the method will be used throughout the region to screen new pesticides.

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DISCRIMINATION TECHNIQUES IN MEAT ACCEPTANCE STUDIES

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An analysis of the utility and limitations of various methodologies used in recent studies of visual and eating preferences for several meat cuts is presented. Included are comparisons of trained laboratory panels, untrained laboratory panels, small household consumer panels, and large metropolitan consumer panels. The smaller panels are especially useful as a means to pre-test schedules, to pre-test subject response to variables being considered, and to develop product control and handling techniques. Major problems are concerned with product standardization, freshness, and other variables arising from the population heterogeneity of the products involved.

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DEVELOPMENT OF A SCALE FOR GRADING TOUGHNESS-TENDERNESS IN BEEF

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The objective of this study was development of an appropriate scale for grading one aspect of beef texture. This required answers to such questions as: Do the qualities, "toughness" and "tenderness," lie on a bipolar psychological continuum? Do they overlap in meaning? How many levels can be discriminated?

Initially, word meaning tests were conducted to assign 41 possibly applicable words and phrases to positions on each of three indicated continua—one of "toughness" only, one of "tenderness" only, and a bipolar continuum. Analysis of the data, using A. L. Edwards method for scaling successive intervals, led to construction of a bipolar scale consisting of 9 intervals, each described verbally.

A second phase of the study compared this scale with an unstructured graphic scale where only the two ends were defined. Groups of subjects used the two to rate samples of commercial, good, and choice unaged beefsteak. The results led to some further modification of the scale.

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CONSUMER SURVEY ON THE DESSERT QUALITY OF CANNED APRICOTS

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A consumer survey was conducted in the city of Davis, California (pop. 6,000), to evaluate the dessert quality of Blenheim apricots from two California growing areas, canned at various sucrose levels. Approximately 600 individuals, representing 200 families selected at random, participated. One hundred families evaluated apricots grown in growing area A, whereas 100 families received samples of fruit grown in growing area B. These apricots were packed in the Department's pilot plant with ingoing sucrose concentrations of 30°, 40°, 50°, 60°, or 70° Brix syrups.

Each family participating in the survey received one can from each sweetness level and was asked to taste each sample separately, as a dessert after a regular family meal. The taster indicated his opinion of the dessert quality by use of an hedonic scale. In addition, family members were required to record the time of day the fruit was tasted, and their age, sex, height and weight, in order to determine whether a relationship existed between these factors and sweetness level preferences.

The data collected from the survey were compared against chemical and physical measurements of the canned fruit, *i.e.*, soluble solids, pH, total acids, and soluble solids-acid ratio.

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SERVICEMEN'S ATTITUDES TOWARD SOLUBLE COFFEE

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Marked increases in civilian use of soluble coffee during recent years indicate that consumer attitudes toward this product are changing. The present experiment was designed to evaluate Servicemen's attitudes toward soluble coffee and determine whether they would be affected by constant use of the product.

Soluble coffee was served regularly over periods of 3–6 months at four military installations representing a total population of about 90,000 men. Questionnaire surveys were conducted before and after this period at the test and at control installations in which respondents indicated preferences for a number of foods including coffee and soluble coffee. Approximately 5,700 respondents were randomly sampled at test, and 7,000 at control installations.

An unfavorable attitude was clearly demonstrated, and it tended to increase in intensity after use of the product. There was no evidence that preference for other foods was lowered. Differences in attitude related to age, branch of service, and coffee drinking habits are discussed.

Influence of Moisture Content on Keeping Quality of Dry Beans

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VERY LITTLE WORK has been published on the keeping qualities of dry beans. Probably the main reason is the fact that beans are one of our more stable foods. The work reported here shows that given favorable storage conditions, their rate of deterioration is very slow, but if held under unfavorable conditions they are subject to considerable loss of quality. The relative humidity of the storage atmosphere is an important factor in the overall conditions affecting their keeping quality.

EXPERIMENTAL

Scope of study. The influence of moisture content on the keeping quality of beans was studied over the range from very low values of 3 to 4%, to 15 to 16%. At levels higher than the latter values beans would be subject to mold growth *(6)*. Each variety studied was adjusted to several moisture contents covering most of this range. Samples of all moisture levels were stored at 77° F. (25° C.). In addition to the material stored at 77° F., samples of each variety of about 10% moisture were stored at —10° F. (—23.3° C.). These served as control material.

The beans were evaluated for quality at the beginning and after storage intervals of 6, 12, and 24 months. Both objective and subjective tests were used in studying the bean quality. The objective tests were determinations of acid value of lipid fraction and bean catalase and phosphatase activities. The subjective tests included flavor, texture, and color of cooked samples.

The textures of both the cotyledons and seedcoats were determined. The detailed findings of skin texture and color of cooked samples are omitted from this report, however, since the changes observed in these factors appeared to have less effect on acceptability than the flavor and texture of the cotyledons.

Catalase and phosphatase were selected as constituent proteins that would provide a sensitive means of detecting minor changes in the bean protein fraction.

Materials. The beans used were obtained from different sources. Members of the staff of the Idaho Experiment Station supplied Red Mexicans (University of Idaho No. 3), pintos (University of Idaho No. 78), and Great Northerns (University of Idaho No. 16). These beans were either grown on the Station's experimental plots or under conditions known to be satisfactory to the Station staff members. These varieties were received shortly after harvest.

Michelites, grown in Michigan, were obtained from Michigan Bean Company, Saginaw, Michigan. Large limas, probably Ventura strain, were supplied by the California Lima Bean Growers' Association, Oxnard, Calif. The Stockton District Kidney Bean Growers of Linden, California, furnished the light red kidney beans of Calapproved grade. The California small whites were purchased from a grower at Watsonville, Calif. In all instances, the beans secured were from the last growing season's crop previous to procurement.

METHODS

Moisture adjustment in beans prior to storage. Six varieties of beans were adjusted to 6 moisture contents in the approximate range of 4 to 15%. The California small whites were adjusted to only 5 moisture levels. Moisture increases were obtained by placing 3 kilograms of beans for such desired moisture level in a high-humidity atmosphere at 77° F. Thin layers of beans were placed on trays of a laboratory model Proctor-Schwartz drier. The bottom tray of the drier was filled with water in which several sponges were placed to increase the surface area available for evaporation. The cabinet was sealed and the air circulated by the fan. By this procedure a relative humidity of about 98% was obtained. The samples were weighed daily. In those instances where the total increase in moisture content was more than about 3% the humidification was carried out in steps in order to prevent some beans from becoming moldy. The stepwise increase in moisture was accomplished by removing the beans from the humidity chamber, after small increases in moisture, and storing them in desiccators for a few days to allow moisture equilibration within and between individual beans. The beans were returned to the humidity chamber and the process repeated until the total weight gained indicated the desired moisture content had been attained.

In cases where it was necessary to reduce the moisture level, the beans were dried in a vacuum of 4 mm. Hg. at 110° F. (43.3° C.) to the desired moisture content. Following the moisture adjustments the California small white variety was stored in desiccators. The other 6 varieties were hermetically sealed in No. 2 cans.

Moisture determinations. The Makower *et al. (4)* vacuum oven method was used for the moisture determinations.

Determination of acid value of lipid. In the early part of this work it was observed that moisture content affects the extractability of the lipid and the acid value of the lipid extracted. Since this work dealt with beans of various moisture contents it was necessary to find a solution to this problem if the lipid acid value was to be included in this study. Since the lipid was more difficult to extract at low than at higher moisture levels, drying of all samples before extraction did not appear attractive. A few exploratory experiments showed that it was possible to adjust the moisture content of the ground bean samples immediately before extraction. After a careful study of conditions necessary to obtain consistent results, the following procedure was adopted.

The beans were ground to pass through a 20-mesh screen. Samples of the ground material equivalent to 25 g. of dry weight were placed in 100-ml. centrifuge tubes, to which were added 65 ml. of benzene. After the benzene had coated all the bean particles, enough water was added to give a moisture content equivalent to 25%. The water added stratified between the solid bean phase and the upper benzene layer. At this point the centrifuge tubes were securely stoppered and shaken vigorously by hand for about 10 seconds; during this time the added water appeared to be uniformly absorbed by the bean samples.* The samples were shaken vigorously an additional 30 minutes on a shaking machine. After shaking they were centrifuged mildly for five minutes and the supernatant was decanted through rapid-flow fluted filter paper into 50-ml. glass-stoppered graduates.

The lipid content of the extracts was determined by weighing the residues after evaporating 10-ml. aliquots from weighing bottles on a steam bath. The acid value of the lipid was determined by titrating 25-ml. aliquots of the extract to which 25 ml. of 99% isopropanol was added. The acid was titrated with 0.01*N* KOH in 99% isopropanol using as an indicator six drops of a 1% phenolphthalein solution in 99% isopropanol. The titrations were carried out in a vessel designed so that CO_2-free air could be forced in from the bottom. The rate of flow of air was adjusted to give rapid mixing of the titer medium during the titration. The alkali was added fairly rapidly until a definite

* In some initial experiments the moisture adjustments were made by adding finely powdered ice to the ground samples that had been cooled to 0° F. After thorough mixing of powdered ice with samples, the flasks containing the beans were removed from the 0° F. room and placed on a shaking machine and vigorously shaken until the samples warmed to room temperature. The results on samples treated in this manner were later shown to be obtainable by the procedure described in which liquid water was added after addition of benzene.

pink color appeared throughout the solution. This was accepted as the endpoint even though fading occurred on standing. With this technique duplicates usually agreed within 0.05 ml. of alkali. The gross titer values were corrected for the values obtained on the reagent blanks.

The lipid acid value is defined as the milligrams of potassium hydroxide equivalent to the acid in one gram of extracted lipid. The formula used to calculate the values was

$$\text{Acid value} = \frac{(\Delta \text{ ml. KOH}) \text{ (normality of KOH) } (56.1)}{\text{grams of lipid titrated}}$$

Extraction procedure for assay of catalase. After some preliminary work on methods of preparing extracts for catalase assay, the following procedure was adopted. A sample of beans equivalent to 25g. dry weight, sufficient cold distilled water to make a total volume of 400 ml. and about 1 gram of calcium carbonate were blended in an electrical blender for 3 minutes. The blend was allowed to stand for 10 minutes and then blended an additional 3 minutes. After filtering through a milk filter the extract was assayed for catalase activity *(1)*.

Phosphatase extraction procedure. A sample of beans equivalent to 25 g. dry weight, 20 g. of sodium chloride, and sufficient cold distilled water to make a total volume of 400 ml. were blended 3 minutes. The blend was allowed to stand 10 minutes, blended an additional 3 minutes, and filtered through a milk filter. The filtrate was assayed for phosphatase activity by a method developed in this Laboratory for beans with the substrate, sodium phenolphthalein phosphatase described by Huggins and Talalay *(3)*.

The complete enzyme reaction mixture consisted of 5 ml. of 1*M* acetate buffer (pH 5.90), 10 ml. of substrate (0.005*M* sodium phenolphthalein phosphate, i.e., 0.304 g. per 100 ml.), and sufficient distilled water so that the enzyme solution made a total volume of 50 ml. Varying with enzyme activity, aliquots of 1 to 4 ml. of the bean extracts were used. The assays were made at 98.6° F. (37° C.).

Five-ml. aliquots of the reaction mixture were drawn at 0, 5, and 10 minutes, or 0, 10, and 20 minutes, depending on enzyme activity, and added to 5 ml. of 0.25*M* glycine buffer pH 10.6. The color values of the solutions due to free phenolphthalein were read in a Klett-Summerson colorimeter with filter No. 54. The phenolphthalein equivalents to the delta colorimeter values were read from a standard curve prepared from data obtained with known amounts of phenolphthalein.

TABLE 1

Cooking times and amounts of water used for each variety

Variety	Cooking time, minutes	Ml. water for 75 grams of beans
Great Northern	60	300
Large lima	25	375
Michelite	80	325
Pinto	70	300
Red kidney	50	300
Red Mexican	90	325
California small white	90	300

The phosphatase activities of the control samples are expressed in the text as the milliequivalents of phenolphthalein freed per hour per gram dry weight of beans. The activities of the other samples are expressed in Table 2 as the percentage of the activities of the controls set at 100%. This seemed advisable since the activities of some varieties appeared to increase with storage. The observed increases also occurred in the control samples stored at —10° F. The apparent anomaly may have been due to a change in the supply of substrate used that was required during the course of the work.

Gas analysis. The gas analyses were made in a conventional type of apparatus. The carbon dioxide was absorbed in alkali and the oxygen in acid chromous chloride solution.

Appraisal. Approximately 75 g. of beans were washed quickly in cold running water. They were lowered into rapidly boiling water for one minute in order to minimize the number of "hard shell" beans *(5)* and were soaked in 300 to 375 ml. of 0.5% salt solution for 17 hours at 40° F. (4.4° C.). The beans were brought to a boil and simmered for the times given in Table 1. The weight of beans and liquid in Table 1 are for the control samples. These weights were varied for the different moisture levels in order to make the total moisture the same for all samples of one variety. The amount of liquid used was enough to keep the beans barely covered during cooking. If they became too dry, 50 to 100 ml. more water was added to all samples.

Exceptions to the general procedure were as follows: (a) the 3.4%-moisture Great Northern sample was given a four-minute pretreatment because with one to 3 minutes quite a few beans did not swell and remained hard shelled; (b) the large lima beans were soaked without pretreatment; (c) the 4.1%-moisture large lima bean sample was cooked only 15 minutes rather than 25 because with longer cooking it became extremely mushy.

Three or four samples were judged per session. When there were 5 samples to appraise they were presented in an incomplete block, 4 at a time for 5 sessions. For the appraisals of the unstored beans all samples were presented except the next-to-lowest moisture content. (All moisture levels were presented in the California small white series). The two lowest moisture samples were generally not appraised at the 6-months' storage interval because these were not expected to show any change. At subsequent storage periods some of the highest-moisture samples were not appraised if they received a very low score for flavor or texture on a previous appraisal, or if a preliminary panel considered them not acceptable.

Samples for flavor, cotyledon, and skin texture evaluation were served under colored lights in order to mask color differences, and prevent bias. Color was scored on separate samples under 200-watt tungsten lamps with daylight filters. For each appraisal there were 9 to 13 judges and 4 replications. The judges had been trained and selected for tasting dry beans. Fewer differences were found for skin texture and color than for other factors, but where skin texture differences were noted they paralleled the cotyledon texture results. Therefore skin texture and color scores were omitted from Table 2. The scoring scale was as follows: 7 = *no off-flavor*, 1 = *much off-flavor*, 7 = *soft cotyledons*, 1 = *firm cotyledons*.

At the initial appraisal for all varieties, except the California small white beans, an additional sample of the control material was served as a labeled standard with a score of 5. Thus the judges could score samples above or below the labeled standard. After the initial appraisals the control material stored at —10° F. was coded and treated like the other unknowns.

The scores were treated statistically by the analysis of variance, using each judge's means for the 4 replications. The sources of variation were treatment, judges, and error. In order to determine whether there were significant differences among the treatments an observed q was calculated.

$$\text{observed } q = \frac{\text{largest mean} - \text{smallest mean}}{\sqrt{\frac{\text{mean square of error}}{\text{number of judges}}}}$$

If the observed q was greater than the tabular q (tables of q may be found in Dixon and Massey *(2)*, pages 342-343), differences were significant and a Tukey least significant difference (LSD) was calculated. This LSD applies to all possible pairs of treatment means within a group of samples appraised together.

$$\text{Tukey LSD} = \sqrt{\frac{\text{mean square of error}}{\text{number of judges}}} \times \text{tabular q}$$

It should be remembered that the scores in Table 2 are relative rather than absolute. A judge cannot be relied on to remember over several months exactly what score he gave to a particular quality. Only the samples which were actually tasted together (one variety at one storage period) can be compared directly. Relative deterioration of a sample may be observed by comparing the scores of several samples with the —10° F. control. It is not justifiable to read the scores across the columns in Table 2 and compare results at different storage periods.

RESULTS AND DISCUSSION

The results of all the tests have been summarized in Table 2. The phosphatase activities of the controls, expressed as described in the section on methods, were Great Northern, 0.20; large lima, 0.04; Michelite, 0.18; pinto, 0.21; red kidney, 0.16; Red Mexican, 0.20, and California small white, 0.10.

The highest moisture sample of each variety suffered

TABLE 2

Influence of moisture and 77° F. storage on catalase and phosphatase activities, lipid acid values, composition of atmosphere in cans, and flavor and texture of cooked samples in seven varieties of beans

Moisture %	Catalase, K values, months				Phosphatase,[1] months				Lipid acid values, months				Can atmosphere after 3 yrs.		Flavor scores and LSD 0.05, months				Texture scores and LSD 0.05, months			
	0	6	12	24	0	6	12	24	0	6	12	24	% CO_2	% O_2	0	6	12	24	0	6	12	24
Great Northern Univ. Idaho 16																						
3.5	0.64	0.65	0.51	0.58	95	109	105	100	17.7	17.1	15.9	17.1			4.9		5.6	6.2	4.7		5.5	6.0
6.0	0.76	0.67	0.67	0.78	98	113	110	93	18.4	16.0	15.4	16.7	0.8	17.8								
8.4	0.68	0.68	0.75	0.68	98	120	97	106	18.1	17.0	15.7	16.4	0.6	17.5	4.7	5.6	5.5	6.3	4.6	5.0	5.2	5.9
10.7	0.69	0.69	0.54	0.69	100	100	101	101	17.4	15.1	14.5	17.0	1.3	15.8					4.7	5.3	5.2	5.4
10.7[2]	0.69		0.69	0.73	100	100	100	100	17.4		14.7	15.4				5.7	5.7	6.3		5.0	5.6	6.1
12.7	0.65	0.68	0.59	0.69	93	102	104	97	17.7	15.8	17.3	23.3	4.2	10.4	4.4	4.3	3.5	3.8	4.7	4.3	3.1	2.3
15.3	0.69	0.52	0.56	0.25	92	104	45	8	17.2	22.0	35.5	61.2	22.7	0.8	3.9	3.1			4.6	2.3		
															0.6	0.9	1.0	0.7	NS[3]	0.5	0.6	0.6
Large lima																						
4.1	0.80	0.79	0.81	0.79	100	103	96	72	15.8	15.0	17.3	16.8	0.4	3.2	4.7		4.5	2.7	4.8		5.8	5.4
6.6		0.71	0.88	0.98		95	96	107		14.3	15.7	14.2	0.9	15.7				5.1				6.4
9.2		0.87	1.05	0.85		100	94	112	14.4	14.8	14.8	15.5			4.9	5.0	4.6	5.1	5.0	5.1	5.1	5.6
12.0	0.75	0.91	1.01	0.76	100	90	87	85	15.7	14.2	16.0	15.4	1.9	13.8	4.7	5.0	4.2		4.8	4.2	3.6	
12.0[2]		0.82	0.98	0.97		100	100	100		14.0	14.1	13.5				5.1	4.6	4.9		5.5	5.0	5.5
14.7	0.90	0.93	0.87	0.73	93	82	70	72	13.4	13.9	15.1	19.1	13.8	0.0	4.6	4.3	3.9		4.4	1.8	1.3	
15.8	0.86	0.76	0.80	0.72	90	97	30	22	13.4	15.6	19.0	46.0	21.0	0.4	4.4	4.1			4.2	1.4		
															NS	0.7	NS	0.7	0.7	0.6	0.8	0.6
Michelite																						
5.1	0.23	0.20	0.24	0.25	135	102	102	103	13.5	13.8	14.1	12.7	0.0	17.8	4.9		5.8	6.3	5.1		6.0	6.3
7.0	0.25	0.21	0.25	0.25	111	98	103	99	13.3	12.8	14.0	13.1	0.0	18.0								
9.4	0.20	0.21	0.20	0.25	113	101	99	104	12.6	12.8	14.4	13.5	0.9	17.1	4.9	5.8	5.7	6.0	4.9	5.9	5.5	5.8
10.5	0.30	0.22	0.24	0.22	100	94	94	99	11.8	12.6	13.6	13.7	1.0	16.8	4.8	5.4	5.1	5.4	5.1	5.3	5.2	5.0
10.5[2]		0.21	0.23	0.25		100	100	100		13.0	13.0	11.9				5.8	5.7	6.3		5.6	5.6	5.9
14.3	0.27	0.23	0.18	0.13	96	105	90	52	13.3	16.0	21.1	29.0	16.0	1.2	4.5	4.7	3.4	3.9	4.5	4.0	2.9	2.2
16.7	0.23	0.17	0.13	0.07	102	38	16	5	13.2	22.4	33.3	52.6	30.0	0.2	4.9	4.5			4.2	3.0		
															NS	0.6	1.0	0.6	0.6	0.6	0.6	0.5
Pinto																						
4.5	0.63		0.67	0.53	104		101	97	14.6		14.4	14.4	0.9	13.0	4.7		5.6	6.1	4.4		4.8	4.8
5.8	0.61		0.66	0.63	91		100	94	13.9		13.7	14.5	0.3	14.0				6.1				5.1
7.5	0.68		0.59	0.66	104		105	98	13.7		13.4	14.3	0.5	15.0	4.7	5.7	6.0	6.2	4.7	5.5	5.4	5.5
10.4	0.63		0.50	0.66	100		103	97	12.9		13.0	13.8	1.8	12.0	4.8	5.8	6.0	5.9	4.8	5.6	5.7	5.5
10.4[2]			0.77	0.68			100	100			12.7	13.8				5.9	5.8	6.5		5.6	5.4	5.8
13.0	0.67		0.59	0.53	95		93	98	13.1		14.0	17.5	4.4	6.5	4.7	5.7	3.7		4.8	5.2	3.7	
15.4	0.59		0.48	0.37	89		57	36	12.5		24.3	41.5	18.3	0.5	4.9	4.0			4.8	3.4		
															NS	0.7	0.9	NS	NS	0.5	0.6	0.4
Red kidney																						
4.9	0.75	0.82	0.68	0.72	102	115	64	100	18.9	19.1	18.7	19.6	0.0	15.4	4.7		5.4	5.8	3.5		3.2	3.5
6.9	0.81	0.82	0.83	0.80	107	109	84	101	19.3	19.5	19.6	19.6	0.2	15.1				6.2				5.0
8.9	0.71	0.80	0.81	0.81	99	110	85	97	19.7	19.3	18.2	18.9	1.4	15.1	4.8	5.9	6.1	6.3	5.0	5.8	6.1	6.2
11.3	0.70	0.86	0.78	0.70	100	113	92	104	18.1	18.2	17.4	17.7	2.4	12.2	4.7	6.0	6.2	6.1	5.0	5.8	5.9	6.0
11.3[2]		0.78	0.83	0.86		100	100	100		18.0	18.1	17.8				6.2	6.4	6.6		6.0	6.3	6.4
14.1	0.69	0.66	0.64	0.48	84	112	90	87	17.8	17.9	19.1	24.3	8.1	4.3	4.9	4.9	4.6		4.8	4.9	3.4	
15.6	0.69	0.48	0.40	0.26	106	98	83	34	18.1	19.7	23.3	43.1	17.2	0.1	4.6	4.4			4.7	3.6		
															NS	0.7	0.6	0.7	0.5	0.6	0.6	0.6
Red Mexican, Univ. Idaho 3																						
3.3	0.96	0.74	0.80	0.80	123	109	118	106	13.8	13.3	13.6	15.4	0.6	12.4	4.7		5.9	6.2	4.6		5.4	5.8
6.2	0.81	0.86	0.81	0.92	124	94	110	106	13.4	13.4	13.6	13.4	0.8	13.5								
7.8	0.85	0.81	0.88	0.95	112	100	102	103	13.9	13.3	12.9	13.9	1.5	13.5	4.8	5.4	6.2	6.4	5.0	4.5	5.4	5.7
9.9	0.94	0.84	0.86	0.88	100	88	100	106	13.7	12.5	13.6	13.7	2.3	12.1	4.8	5.4	6.2	5.9	4.7	4.7	5.4	5.4
9.9[2]		0.84	0.85	0.88		100	100	100		12.1	13.8	12.9				5.6	6.1	6.4		4.9	5.5	5.8
12.4	0.92	0.86	0.75	0.75	113	100	108	109	13.0	12.7	14.0	16.2	4.9	6.5	4.7	5.5	5.0	4.5	4.8	4.6	4.6	3.7
13.6	0.98	0.81	0.80	0.65	117	103	106	93	12.9	13.8	16.6	26.3	13.4	0.4	4.4	4.4			4.7	4.2		
															NS	1.0	0.6	0.6	0.3	0.4	0.3	0.4
California small white																						
8.9		0.63				101	82		10.7	12.8	12.5	13.6[4]			5.7	6.1	5.5	6.0[5]	5.3	5.3	5.2	5.2[5]
9.7		0.66				102	85		12.1	12.5	13.0	13.8			5.8	6.0	5.6	6.0	5.3	5.0	5.2	5.1
12.8		0.63				95	88		11.9	13.1	14.7	15.6			5.9	4.6	4.4	3.9	4.9	4.5	4.1	2.8
15.2		0.40				91	74		11.2	14.8	26.3	31.9			5.3	4.6	3.9		4.7	3.3	2.5	
17.5		0.02				52	5		11.2	21.6	46.5	56.5			5.4	4.1			4.7	2.4		
															NS	0.9	0.7	0.6	0.4	0.6	0.6	0.4

[1] The phosphatase activities are expressed as percent of the activities of the control samples.
[2] Control sample stored at —10° F.
[3] NS indicates that the treatments were not significant.
[4] Samples stored 17 months.
[5] Samples stored 3 years.

significant quality loss in 6 months, as judged by flavor and texture evaluation. The second-highest moisture samples of several varieties also lost quality in 6 months. The acid value of the lipid increased significantly in 6 months in the highest moisture samples of Great Northern, Michelite, and California small white varieties. During this time the samples of Michelite and California small white lost about one-half of their phosphatase activities.

After storage for 12 and 24 months the samples of beans in the higher moisture range had deteriorated markedly in quality. Even after 12 months the highest moisture sample of each variety was so objectionable in flavor that it was not appraised formally by the members of the panel. There was a fair correlation between loss in quality as indicated by flavor and texture, and the increase in the lipid acid value. With large losses in quality there usually were significant losses in enzyme activities of the samples. The loss in the enzyme activities, however, was not correlatd as well with loss in eating quality as was the increase in acid values. Samples of 12% moisture, and above, after 24 months' storage were in general very objectionable in flavor and texture.

In contrast to the unstable character of beans of 12% moisture and above, beans in the lower moisture range of 4 to 10% maintained their quality quite well. The lowest-moisture samples, particularly of pinto and red kidney varieties, had a slight tendency to cook unevenly. In most cases, however, beans below 10% moisture compared favorably after 24 months' storage with the control samples stored at low temperature. The stable character of beans in the low moisture range was apparent in the flavor and texture tests and also in the enzyme and acid values.

One notable exception, however, was observed in the stability of beans of low moisture. The lima bean sample of 4.1% moisture did not follow the pattern observed for the other varieties. These beans were different from all others in two respects. At all appraisal times they required only about one half as much cooking as the other lima bean samples. During the short cooking the cotyledons appeared to fracture or break up into small pieces and the entire sample became quite mushy. After 2 years' storage these beans had a very objectionable (perhaps rancid) flavor. The 6.6% moisture sample of lima beans had good quality after 2 years' storage.

With the exception of the low-moisture lima bean sample no varietal variation was observed. Figure 1 shows the similarity of the lipid acid values for the different varieties after 2 years' storage. This Figure also illustrates very clearly the relationship between moisture content and the development of lipid acidity. Varietal similarity in flavor scores as a function of moisture content is shown in Figure 2 for beans stored 2 years. Figures 1 and 2 summarize data that illustrate vividly the stability advantage to be gained by lowering the moisture content.

A careful study of the lipid acid value data for all varieties in relation to their general eating qualities

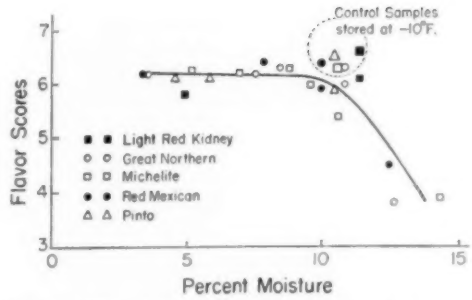

Figure 1. Flavor scores vs. moisture content of dry beans stored 2 years at 77° F.

indicates that a sample of beans that has an acid value of 20 will be quite unapalatable.

Moisture content appeared to have more influence on color changes of dry pinto beans than on the other varieties studied. After storage for a year the color of the dry samples of 13 and 15.4% moisture had greatly intensified while the color of the samples of 10.4% moisture and below compared quite favorably with the control sample stored at low temperature. There was some change in the low-moisture samples, however, but the lower the moisture content, the smaller the color change.

During the first two years of this study no attention was given to changes in the gaseous atmospheres in the cans in which the beans were stored. However, the air in some cans that were stored for 3 years was analyzed for the carbon dioxide and oxygen. The cans contained about 300 grams of beans, and a free gaseous space of approximately 350 ml. The results are shown in Table 2. The highest-moisture samples of the 6 varieties stored in cans used practically all of the oxygen and produced 13 to 30% carbon dioxide. In the moisture range where the beans maintained good quality, however, there was not much difference between samples in oxygen consumption or carbon dioxide production. Again there was one notable exception. The 4.4% moisture sample of lima beans consumed most of the oxygen available in the can.

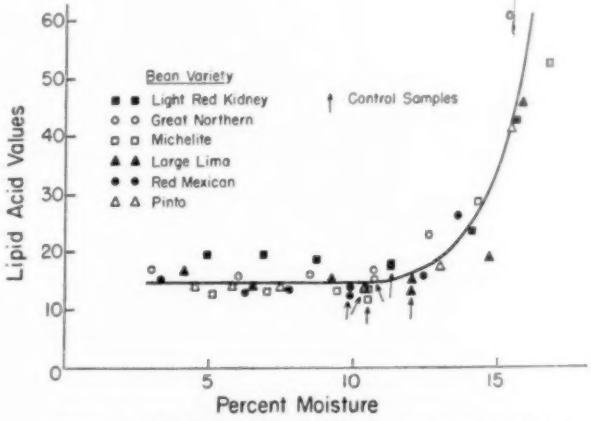

Figure 2. Acid values of lipid fraction in 6 varieties of dry beans of different moisture content stored 2 years at 77° F.

CONCLUSIONS

Moisture content of dry beans is a most important factor influencing their stability. Above 13% moisture beans deteriorate in flavor and texture significantly in 6 months at 77° F. In 12 months they become very unpalatable in flavor and texture and in most instances increase significantly in lipid acid value. A lipid acid value of 20 or more indicates low organoleptic quality.

Losses in catalase and phosphatase activities are not correlated as well with losses in quality as are changes in lipid acid value.

Beans below 10% moisture maintained their quality for two years at 77° F. almost as well as control samples stored at —10° F.

Acknowledgments

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Effect of Different Fats and Oils and Their Modification on Changes During Frying[a, b]

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A number of studies of deep fat frying under conditions likely to be found in the home have reported changes in fat constants as an indication of decomposition during frying. Blunt and Feeney *(3)* studied the smoking temperature of fats and noted considerable variation from one fat to another. In a report of changes in fats used for frying doughnuts, Morgan and Cozens *(9)* found the free fatty acid content to increase with increased frying time. King *et al. (5)* reported an increase in free fatty acids of lards and oils after frying about 4 kilograms of potato chips.

Blunt and Feeney *(3)* determined the acidity of the fat samples used for smoke point determinations and found an inverse relationship between smoke point and free fatty acid content. Thiessen *(13)* reported this same type of relationship between smoke point and acidity when frying doughnuts in lard, vegetable oils, or hydrogenated fat with up to 18 hours of use. It was reported by Lowe *et al. (7)* that the smoking temperature varied inversely with the acid number in lards, oil, and hydrogenated fat used for deep fat frying, the correlation being —0.78.

Peroxide numbers of fats were found by Lowe *et al. (7)* to increase with the frying of doughnuts. Most of the lards reached values of from 9.5 to 15.7 after approximately 10 hours of frying. Chang *et al. (4)* showed that peroxide values of lard used for frying doughnuts increased to a maximum after 10 minutes and then decreased to negligible values after 40 minutes of frying. When corn oil was used for frying potato chips, peroxides reached a somewhat higher constant value after 40 minutes of frying. Small decreases in iodine values during frying have been reported by Morgan and Cozens *(9)*, King *et al. (5)*, and Lowe *et al. (7)*.

Previous studies in this laboratory compared the changes in lard produced by the frying of a fritter-type batter or French-fried potatoes. The frying of batter caused a greater degree of decomposition than potatoes as shown by a more pronounced increase in free fatty acid and decrease in smoke point. Peroxide values remained at lower levels with the frying of batter. Iodine and saponification numbers were little affected in either case. Changes in the frying fat were affected by the batter ingredients, baking powder, milk and eggs having great influence on the decomposition of the lard during frying *(2)*.

The effectiveness of an antioxidant in retarding rancidity in edible fats and oils should be tested under actual conditions of use, according to Vibrans *(14)*. A few reports have dealt specifically with the influence of antioxidants during frying. Several antioxidants added to frying fats were found by Kraybill *et al. (6)* to cause a relatively small increase in the time required for a rancid odor to develop in potato chips stored at 145° F. in a Schaal oven whereas those fats containing butylated hydroxyanisole showed considerable carry-through. Magoffin and Bentz *(8)* also found that butylated hydroxyanisole possessed carry-through effect when present in fats used for the deep fat frying of potato

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chips. Sair and Hall *(11)* suggested that an antioxidant salt added to potato chips after frying was effective in increasing the shelf life of the chips.

A panel of 4 judges was used by Lowe *et al. (7)* for scoring the palatability of doughnuts. In general, doughnuts cooked in fat after it had been used for frying about 8 hours were less palatable than the first doughnuts cooked in the fat. Exceptions were for lards with a strong initial odor, where the reverse was true. In general, the hydrogenated fats and corn oil produced higher scoring doughnuts than the lards. Thiessen *(13)* submitted doughnuts to a taste panel and found that the judges could rarely distinguish between fats used for frying except in the case of lard. Only the cheaper grade of lard was rated undesirable. Discoloration of lard and hydrogenated fat after 12 or 18 hours of use apparently had little effect on the flavor of foods cooked in it.

It is apparent that reports of studies concerned with deep fat frying under home conditions have included little information for some of the newer types of fats. Changes in processing techniques and the addition of antioxidants and emulsifying agents have produced fats which differ greatly in qualities from those previously known. The general plan of the present study is concerned with changes in such fats and oils during frying and is outlined below in 3 series.

EXPERIMENTAL PROCEDURE

General procedure. Two types of foods were fried. French-fried potatoes were prepared in 500 g. lots and fried at an initial temperature of 196° C. for 11 minutes. A fritter-type batter containing all-purpose flour, sugar, tartrate baking powder, and salt, sifted together and added to an egg and milk mixture, was prepared in individually mixed batches of 410 g. each, and fried in 2 lots of 6 balls each at a temperature of 190° ± 5° C. for approximately 8 minutes. A household type electric deep fat fryer, 62 sq. in. top surface area, was used.

Fat samples were taken at intervals for determination of one or more of the following fat constants: percent free fatty acid calculated as oleic acid, peroxide numbers by the method of Wheeler *(15)*, iodine numbers by the method of Rosenmund and Kuhnhenn *(10)*, and saponification numbers as given by Williams *(6)*. Smoke points were determined with an apparatus constructed essentially according to specifications of the American Oil Chemists' Society *(1)*. The method of Sidwell, Salwin, and Mitchell *(12)* was followed for the reaction of fats with thiobarbituric acid.

Series I. The influence of added monoglycerides on the frying fat. A total of 6.5 kg. of potatoes was fried in samples of a lard rendered by a low temperature, continuous process and to which 0, 2, 4 or 6% monoglycerides, manufactured from cottonseed oil, had been added. Fresh fat of the same composition as the original was then added to the lards containing 0 and 6% monoglycerides and a total of 20 batches of the fritter-type batter fried in each fat. Fat absorption of the potatoes was determined by weighing the fat and fryer at intervals and calculating the absorption by difference.

Series II. The effect of processing and of antioxidants on lard used for frying potatoes. A total of 16.5 kg. of French-fried potatoes was cooked in steam rendered and in continuous process lard, each with and without 0.05% antioxidant. The antioxidant contained a mixture of propyl gallate, butylated hydroxyanisole, and citric acid in propylene glycol.

Series III. A comparison of changes in various types of fats produced by frying fritters. A total of 20 batches of fritters was fried in each of the following fats: steam rendered and continuous process lard, each with and without 0.05% antioxidant, cottonseed oil, peanut oil, and two combination shortenings containing rearranged or "molecular-modified" lard mixed with other fats, an antioxidant mixture and mono and diglycerides. A trained taste panel of 9 members compared the palatability of the twentieth batch of fritters to that of the second batch fried. Volatile substances given off from the top of the fryer during the frying of 18 batches of batter were collected in 95% ethanol by the use of a rigid plastic hood connected to an absorption train and vacuum pump. The alcoholic extracts were examined qualitatively.

RESULTS AND DISCUSSION

The data in Table 1 show that the addition of monoglycerides changed the smoke point of the lard markedly. This effect was immediate, before the fat was used in frying, and was proportionately greater with the addition of 2% monoglycerides than with 4 and 6%. In itself, this would tend to make the fat undesirable for frying purposes because of the volatile products which were given off at relatively low frying temperatures.

TABLE 1
Effect of monoglycerides on smoke points (°C.) of continuous process lard

Percent monoglycerides	Weight of potatoes fried in kilograms		After fresh fat added	Number of batches* of batter fried	
	0.0	6.5		10	20
0	214	211	213	182	170
2	165	181			
4	145	171			
6	140	159	155	162	158

* Each batch weighed 410 g. before frying.

Little change in smoke point was noted in the control fat when potatoes were fried, but there was a definite trend to decreased smoke points with the frying of fritters. With the frying of potatoes an increase in smoke point occurred in every case when monoglycerides were present. Evidently, the loss of volatile substances which were exerting an effect on the lowering of smoke point would be responsible for this increase. After fresh fat containing 6% monoglycerides was added to the partially used fat and fritters fried, little change in the smoke point was noted. However, the smoke point originally was much too low for a desirable frying fat.

Because of the action of monoglycerides in emulsifying fat to be used in baked products, the possibility of a change in the amount of fat absorption by the fried products when these materials were present in the frying fat was considered. Weighings for the amount of fat absorbed by 500 g. of potatoes were made after 2.0 kg., after 4.5 kg., and after 6.0 kg. of potatoes had been fried. Results are given below:

Percent monoglycerides	Grams of fat absorbed per 500 grams of potatoes		
	Sample 1	Sample 2	Sample 3
0	22	20	18
4	18	20	19
6	21	20	19

There appeared to be no difference in the amount of fat absorbed by French-fried potatoes, with or without the addition of monoglycerides to the fat.

The results of fat constant determinations on lards produced by different methods of processing, both with and without antioxidant (Series II), are shown in

Table 2. The smoke points were much higher at the beginning of frying in the continuous process lards and an antioxidant had no effect on the gradual decline in smoke point. The free fatty acid content increased gradually without attaining very high values, the antioxidant having a very slight effect in keeping the acidity at lower levels. Acidity was considerably greater in the steam rendered lards than in the fats rendered by the continuous process.

TABLE 2

Fat constants of the fat used in frying potatoes as affected by different processes and the addition of antioxidants

Fat constant	Potatoes, fried, in kilograms	Continuous process lard		Steam rendered lard	
		With no antioxidant	0.05% antioxidant [1]	With no antioxidant	0.05% antioxidant [1]
Smoke point in ° C:	0.0	223	224	197	194
	5.5	223	223	196	191
	11.0	219	220	192	188
	16.5	210	213	189	186
Percent free fatty acid:	0.0	0.12	0.10	0.28	0.27
	5.5	0.17	0.16	0.36	0.34
	11.0	0.17	0.16	0.39	0.42
	16.5	0.25	0.22	0.45	0.49
Peroxide number:	0.0	0.56	0.48	0.59	0.43
	5.5	12.26	3.30	5.47	3.39
	11.0	9.51	4.80	6.73	5.28
	16.5	11.85	9.39	7.04	6.86
Iodine number:	0.0	61.3	65.1	61.0	61.9
	5.5	62.8	63.6	62.3	64.6
	11.0	63.3	63.0	61.3	63.8
	16.5	62.6	61.9	61.2	63.7
Saponification number:	0.0	195.0	193.6	195.5	197.9
	16.5	194.5	196.7	195.8	195.9

[1] Propyl gallate, butylated hydroxyanisole, and citric acid in propylene glycol.

In general, the peroxide numbers were lower in the steam rendered than the continuous process lards, although the peroxide values showed somewhat erratic results. For each lard the peroxide numbers increased as potatoes were fried and especially so for the continuous process lard without antioxidant. The addition of an antioxidant gave a lower peroxide value at every stage and for each lard. Iodine and saponification numbers showed some change but did not appear to be significantly affected by differences in processing, by addition of antioxidants, or by the frying of potatoes.

The changes in fat constants of different types of fats used for frying fritters are shown in Tables 3 and 4 (Series III). The general trend of changes was similar for all fats tested and included a gradual decrease in smoke point, an increase in acidity, and maintenance of extremely low peroxide values throughout the frying period. Although the vegetable oils and the continuous process lards had a substantially higher initial smoke point than the other fats, this difference between them was appreciably narrowed by the end of the frying. The vegetable oils had a somewhat lower final value for free fatty acid than most of the other fats studied, although the continuous process lard was close to this figure, especially when antioxidant was present. An inverse relationship between smoke point and free fatty acid content may be noted. The increase in acidity and decrease in smoke point were much more pronounced in

TABLE 3

Smoke point and percent free fatty acid of different types of fats used for frying a fritter-type batter

Fat constant	Number of batches of batter fried	Steam rendered lard	Steam rendered lard with antioxidants [1]	Continuous process lard	Continuous process lard with antioxidant [1]
Smoke point in ° C:	0	188	189	213	215
	2	186	187	212	213
	5	183	184	205	206
	10	176	178	193	187
	20	169	170	178	180
Percent free fatty acid:	0	0.36	0.33	0.15	0.11
	2	0.26	0.35	0.23	0.18
	5	0.46	0.61	0.34	0.25
	10	0.75	0.70	0.48	0.45
	20	1.41	1.19	1.00	0.89
		Combination shortening I	Combination shortening II	Cottonseed oil	Peanut oil
Smoke point in ° C:	0	191	177	229	230
	2	189	175	229	229
	5	187	174	222	223
	10	180	176	202	203
	20	168	163	180	178
Percent free fatty acid:	0	0.13	0.03	0.11	0.12
	2	0.21	0.14	0.17	0.08
	5	0.24	0.40	0.23	0.15
	10	0.62	0.56	0.29	0.30
	20	1.30	1.25	0.83	0.83

[1] 0.05% propyl gallate, butylated hydroxyanisole, and citric acid in propylene glycol.

TABLE 4

Peroxide, iodine, and saponification numbers of different types of fats used for frying a fritter-type batter

Fat constant	Number of batches of batter fried	Steam rendered lard	Steam rendered lard with antioxidant [1]	Continuous process lard	Continuous process lard with antioxidant [1]
Peroxide number:	0	0.99	0.61	1.80	0.61
	2	2.20	0.67	2.30	0.70
	5	0.81	0.76	2.29	0.92
	10	0.84	0.75	1.44	0.71
	20	1.29	1.00	1.32	1.19
Iodine number:	0	62.4	61.1	62.1	64.0
	20	60.1	60.9	62.0	63.3
Saponification number:	0	195.8	194.9	195.5	196.0
	20	196.8	196.4	196.3	195.8
		Combination shortening I	Combination shortening II	Cottonseed oil	Peanut oil
Peroxide number:	0	2.18	3.12	4.75	7.48
	2	0.55	0.86	0.94	1.05
	5	0.53	0.76	0.61	0.66
	10	0.95	1.13	0.71	0.56
	20	1.35	1.48	0.85	0.86
Iodine number:	0	58.3	58.1	101.4	91.6
	20	58.1	58.0	100.3	90.5
Saponification number:	0	193.5	192.9	195.4	190.3
	20	195.4	194.1	194.2	191.3

[1] 0.05% propyl gallate, butylated hydroxyanisole, and citric acid in propylene glycol.

fats used for the frying of fritters than for those in which French-fried potatoes were cooked.

The peroxide numbers recorded throughout these studies showed considerable variation, but higher ones were obtained when potatoes were fried than with the frying of fritters. Lowe *et al.* (7) reported an increase

in peroxide numbers as doughnuts were fried, but Chang *et al. (4)* found that peroxide numbers of lard used for frying doughnuts decreased to negligible values after 40 minutes of frying. In the present study the second batch of fritters represented approximately 32 minutes of frying time and peroxide values were low in all fats at this period.

Since the degree of decomposition of the frying fats was being measured by changes in physical and chemical constants it would be desirable to relate these changes to differences in palatability of the fried food throughout the frying period. The question was raised as to whether or not the increased acidity, decreased smoke point, and change in peroxide numbers and color, which was a dark brown by the end of the frying, were affecting the flavor and odor of the fried product. The flavor and odor scores of a panel comparing the second batch of fritters with the twentieth batch fried was subjected to an analysis of variance. The F values were significant only for judges in both flavor and odor evaluation. No clear-cut lines of preference for the second or twentieth batch of fritters fried in one fat above another were shown by this panel. It is probable that some of the taste panel members preferred the odor and flavor of greatly used fat above that of fresh lard or oil and that in other cases the reverse was true. Apparently, the frying of 20 batches of fritters did not, as a general rule, cause rancid or other undesirable flavors and odors to develop in the fried product which could be detected, consistently, by the taste panel judges. This result was in general accord with the findings of Thiessen *(13)*.

Collection of vapors given off by the fats during frying was carried out to try to determine the type of volatile substances produced in deep fat frying. The study was not done on a strictly quantitative basis because the hood fitting over the fryer was loose and was raised to insert food materials to be fried. The conditions of frying were kept constant as far as possible, however, and the alcoholic solution in which vapors were captured was made to constant volume at the end of the frying period. From limited tests made on the extracts it was apparent that materials volatilized during frying contained acidic substances which could be titrated with dilute base. Substances which were aldehyde in nature were also present, since a qualitative Kreis test was positive in all samples. A compound which combined with 2-thiobarbituric acid to give a red color was found to be among the substances volatilized from all the fats.

SUMMARY AND CONCLUSIONS

The addition of monoglycerides to continuous process lard to be used in frying French-fried potatoes immediately lowered the smoke point, which tended to increase somewhat as frying proceeded. Fat absorption was evidently not influenced by the added monoglycerides.

A continuous process lard, as compared to a steam rendered lard, maintained a higher smoke point and lower free fatty acid content with the frying of potatoes or fritters. The presence of an antioxidant exerted some effect on peroxide values, but none on smoke point or free fatty acid content.

In a comparison of the changes produced in different fats and oils by frying fritters, the trends of increased acidity and lowered smoke point and peroxide values were found to be similar for all fats tested under these small scale conditions. Palatability tests by panel judges did not consistently distinguish between the flavor and odor of fritter balls fried in fresh or greatly used fats. Neither were preferences for fritters fried in one fat above another apparent from the flavor and odor scores.

Acknowledgment

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Concomitant Use of Radiation with Other Processing Methods for Meat[a, b, c]

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SUBJECTING FOODS to ionizing radiations has been accepted by many workers *(2, 3)* as an effective means of destroying the microorganisms present and thereby effecting preservation. However, it has been recognized that the radiations may impart unnatural flavors to the foods and make them much less acceptable to consumers. The problem has been found to be of concern with most meats and meat products.

The principal advantage of sterilizing foods by ionizing radiations is that sterilization is accomplished with little or no rise in temperature. Consequently a food—for example, fresh red meat—remains essentially fresh, holds its color, and sustains none of the structural impairment of heat sterilization. Sterilizing fresh meat in a sealed container by this method would minimize storage costs and offer the consumer other advantages—for example, the opportunity to cook the meat in any desired or appropriate manner, such as roasting, broiling, or stewing, and to any desired degree of doneness (rare to well done).

In spite of the attractiveness of radiation sterilization as a means of preservation it will not be acceptable unless the unnatural flavors imparted are either eliminated or reduced to a point where the consumer does not recognize them. Hope of solving the flavor problem does not at present seem to lie in the selection of one type of ionizing radiation in preference to another. Equal intensities of gamma rays and cathode rays appear to be about equally capable of producing radiation flavor in meat. However, the greater penetrating capacity of gamma rays as compared to cathode rays gives definite advantage to the former.

Certain hypothetical considerations. Whatever method of food preservation is used, a certain quantitative minimum of the preservation treatment must be applied to reach a given degree of preservation. For instance, if the growth of spoilage microorganisms is to be completely stopped, it may be accomplished in several ways: a minimum amount of heat may be applied; the food may be held at or below a certain low temperature; it may be dried to a certain low moisture content; it may be held in an atmosphere of a certain low oyxgen level; it may have added to it a certain minimum amount of salt, sugar, acid, alcohol, or antibiotic.

Sometimes these minimum quantities of "preservation treatments" cause undesirable changes in the qualities of the foods and thereby reduce acceptability. As an example, so much heat is required for sterilization of canned meat that the product is generally regarded as overcooked. If less heat were applied, the canned meat would be much more desirable in flavor. Likewise, it appeared reasonable to expect that if ionizing radiations could be applied to meat in less than sterilization dosages, the flavor would not be so drastically affected and the meat would be more acceptable to the consumer.

Since the meat must be completely sterilized if it is not to spoil due to microorganisms, there would appear to be only one method of reaching complete sterilization without applying one of the minimum quantities of "preservation treatments" described. This method is to apply less than minimum quantities of two or more of the treatments and depend upon the summation of their effects to be sufficient for sterilization. Although certain facts that concern the nature of the destruction of microorganisms prevent complete acceptance of this concept, it was used as a hypothetical basis for designing the present studies. Objective was to determine the feasibility of achieving sterilization by combining conventional processing or preserving procedures with ionizing radiations in order to reduce the intensities of unnatural flavor resulting from radiations.

Specific objectives of the experiments. Specific objectives of the experiments reported here were:

Objective 1. To determine the effect of irradiation of canned ground beef at dosages lower than 2×10^6 rep (the generally recognized dosage required for sterilization) on the development of radiation flavor.

Objective 2. To determine if canning meat in vacuum or nitrogen is effective in reducing the development of radiation flavor.

Objective 3. To determine if meat or meat products irradiated in the frozen state develop less radiation flavor than when irradiated in the non-frozen state.

Objective 4. To determine the effect of pre-irradiation treatments such as partial and complete cooking and dehydration, followed by irradiation in either the frozen or unfrozen state, on the development of radiation flavor in ground beef and ground fresh pork.

GENERAL PROCEDURE

(a) *Preparation of product.* The meat used in these experiments was freshly ground in a nearby Federally inspected commercial meat packing plant, handled as promptly as possible through all treatments, and then properly refrigerated. The ground beef contained 85% lean and 15% fat. The ground pork contained 60% lean and 40% fat. Neither the beef nor the pork contained salt or other seasoning.

(b) *Preparation for shipment.* In preparation for shipment to and from irradiation at the Materials Testing Reactor at Arco, Idaho, the meat was sealed in "C" enameled No. 2 (307 x 409) cans. Usually a headspace of about 0.75 inch was allowed in

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each can. When the cans were vacuum sealed, 26" (water) vacuum was drawn on the closing machine. When the air in the cans was replaced by nitrogen, the filled containers were evacuated, flushed with nitrogen, re-evacuated and again filled with nitrogen before closing. For product "canned in air," as referred to subsequently, the cans were closed at atmospheric pressures.

After sealing, the cans to be shipped frozen were subjected to air blast at —20° F. The controls, also frozen at —20° F., were held at 0° F. in Corvallis until used. Cans to be shipped in the unfrozen state were held at 32-34° F. until shipment, which occurred within 24 hours after packing.

(c) *Shipment.* During shipment by railroad to the radiation source the cans were kept frozen or chilled with either dry ice or water ice, respectively. During shipment from Arco to Corvallis all the cans (which had been irradiated) were kept either frozen with dry ice or at low temperature with water ice. After the samples arrived in Corvallis, they were held at 0° F. or 34° F. until submitted to taste testing.

(d) *Radiation treatment.* A gamma ray source was used for the irradiation of the cans of meat. Spent fuel rods, suspended at a depth of 16 feet in a water canal, provided the ionizing radiations. The flux, the dosage, and the time of exposure were varied according to the needs of the experiment. The cans of meat sent to the radiation source in the frozen state were irradiated while frozen. Those sent in water ice were irradiated below 78° F.

(e) *Taste testing.* The irradiated meat was held 2 to 3 weeks at 0° F. before taste testing. The meat was served in paper serving cups coded with 3 digit numbers taken from a random number table. The taster scored 4 samples at each sitting. A fifth sample cup, marked with an "R," contained a reference sample for purposes of comparison. The panels were composed of 5 to 12 tasters, seated in isolated booths lighted by an amber light. In some of the experiments an incomplete block design was employed; in others a complete block design was used. The number of treatments dictated the design.

Samples were evaluated on a linear rating scale for intensity of irradiated flavor. This was a line ballot on which the tasters were asked to score the coded samples in direct relation to the reference sample. In certain experiments as indicated the reference sample had been irradiated; in others it had not been irradiated. The line for scoring was 5 inches long with the reference sample arbitrarily pegged at the 3-inch mark. One end of the line was marked "no irradiated flavor" (5-inch mark) and the other "severe irradiated flavor" (0 mark). The numerical score points did not appear on the ballot. After decoding, each taster's score was read from the ballot by means of a ruler divided in 0.1 inches. Thus a numerical score was assigned to each judgment.

Before serving, the thawed samples of uncooked ground beef or pork (including the controls) were formed into patties, broiled under a medium gas flame for 4 minutes on each side, and, with the flame turned off, allowed to cook for an additional 5 minutes. Samples partially or completely cooked before irradiation were warmed over steam in a closed container for 10 minutes before serving. Samples dehydrated before irradiation were mixed with water (90 ml. water to 75 g. of dehydrated meat) and heated in a double boiler for 10 minutes before serving. In each instance the samples were served while warm.

In one experiment non-irradiated and irradiated ground beef were made into meat loaves, with the usual ingredients, and presented to the taste panel.

EXPERIMENTAL RESULTS FOR OBJECTIVE 1

It was first desirable to learn what influence the intensity of flux and length of time of exposure to gamma radiation would have on the intensity of radiation flavor. Samples of fresh ground beef were canned without removal of air, shipped to Arco in water ice, and irradiated for various lengths of time at various flux intensities to a final dosage (Table 1). Ten No. 2 cans were exposed to irradiation for each time period. The samples were returned to Corvallis packed in water ice. The rise in temperature of the product during irradiation is also indicated in the table.

Using a complete block design with 4 replications and 12 tasters the mean flavor scores shown in Table 2 were obtained.

TABLE 1

Flux intensity, time to reach approximately 2×10^6 rep, and temperature rise in irradiating ground beef

	Control	Short exposure	Medium exposure	Long exposure
Flux (r/hr.)	0	4.49×10^5	1.66×10^5	8.3×10^4
Irradiation Time	0	27 min.	12 hrs.	24 hrs.
Dosage		2.2×10^6	1.99×10^6	1.99×10^6
Temperature				
Before Irradiation	32° F.	32° F.	33° F.	33° F.
After Irradiation	34° F. (24 hrs.)	56° F.	78° F.	78° F.

TABLE 2

Mean flavor scores of ground beef subjected to approximately 2×10^6 rep in short, medium, or long periods of time

Control (0 hrs.)	Short exposure (27 min.)	Medium exposure (12 hrs.)	Long exposure (24 hrs.)
4.52	3.29	3.18	3.03

L. S. D.* (0.05) = 0.35.
* Least Significant Difference.

Analysis of variance showed that a significant difference existed between control and irradiated samples. However, no significant differences could be shown between the various times required for equivalent dosage. These experiments show that the irradiation dosage is the main cause of low flavor scores for ground beef and that variations of time and flux intensity would not be expected to contribute significantly to differences in flavor scores.

To determine the effect of irradiation at dosages lower than 2×10^6 rep on the development of irradiation off-flavor and the degree of sterility, 20 cans were packed with ground beef without removal of air. These cans were divided into 5 series of 4 cans each and shipped with dry ice to Arco, where they were irradiated, while frozen, in a flux of 2.07×10^6 r/hr. for the following times to produce the indicated dosage:

	Time	Final dosage
Series A	3 min. 36 sec.	124,200 rep
Series B	7 min. 12 sec.	248,400 rep
Series C	14 min. 24 sec.	496,800 rep
Series D	28 min. 48 sec.	993,600 rep
Series E	57 min. 36 sec.	1,987,200 rep

The cans were shipped in dry ice to Corvallis and stored at 0° F. until they were thawed, cooked, and submitted to taste testing.

For taste testing the complete block design was used; each block was replicated 4 times. The taste panel consisted of 12 tasters. The reference ground beef was the sample irradiated to a dosage level of 1.98×10^6 rep at dry ice temperature (Series E). Mean scores of the treatments are given in Table 3.

TABLE 3

Mean flavor scores of ground beef irradiated at different dosages

Dosage	124,200 rep	248,400 rep	496,800 rep	993,600 rep
Score	4.24	3.95	3.78	3.55

L. S. D. (0.05) = 0.37.

Analysis of variance for linear response between dosage and flavor score showed a highly significant linear relationship between irradiation dosage and flavor score. The flavor score was found to decrease 0.225 for each doubling of the dosage.

Although these irradiated ground beef samples were not compared directly with non-irradiated samples in the taste tests,

it would appear from other tests (Table 2), that a dosage of 124,200 rep may produce a detectable radiation flavor.

EXPERIMENTAL RESULTS FOR OBJECTIVE 2

(a) When the following 10 pre-irradiation treatments of ground beef were tested, each variable consisted of meat packed in air, vacuum, or nitrogen. Each test sample was irradiated to 2×10^6 rep.

(1) Fresh, unfrozen
(2) Fresh, frozen
(3) Partially cooked, unfrozen
(4) Partially cooked, frozen
(5) Partially cooked, dehydrated, unfrozen
(6) Partially cooked, dehydrated, frozen
(7) Completely cooked, unfrozen
(8) Completely cooked, frozen
(9) Completely cooked, dehydrated, unfrozen
(10) Completely cooked, dehydrated and frozen

In not one of the pretreatments was there a significant effect of the vacuum or nitrogen in reducing the intensity of the radiation flavor. The mean flavor scores of ground beef packaged in air, vacuum, or nitrogen, irrespective of the pretreatment, are given in Table 4.

TABLE 4

Mean flavor scores of ground beef canned in vacuum, nitrogen, or air and irradiated to 2×10^6 rep

Non-Irradiated control (air)	Air	Irradiated in vacuum	Nitrogen
4.61	4.16	4.32	4.08

L. S. D. $(0.05) = 0.30$.

As the non-irradiated control was also packaged in air, analysis of variance between the control (air packed) vs. all other media showed that the control was scored significantly higher than the media themselves, which were not significantly different from one another. The effect of irradiation is therefore shown to be the significant factor.

(b) Ground fresh pork canned in air, vacuum, or nitrogen and irradiated to 2×10^6 rep in the unfrozen state provided the flavor scores shown in Table 5. Statistical analysis revealed no significant difference among the 3 media.

TABLE 5

Mean flavor scores of ground pork canned in vacuum, nitrogen, or air and irradiated to 2×10^6 rep

Non-Irradiated control (air)	Air	Irradiated in vacuum	Nitrogen
3.76	3.07	3.13	3.16

L. S. D. $(0.05) = 0.46$.

(c) Frankfurters and bologna also were canned in air, vacuum, and nitrogen before irradiation. The frankfurters were made from an all-beef formula and were stuffed in hog casings. They were packed in cans without brine or water added. The large bologna contained both beef and pork. It was cut to fit the can and was packed without brine or water added.

The frankfurters in cans were irradiated to a dose of 1.98×10^6 rep, using a gamma flux at 6.6×10^6 r/hr. for 18 minutes. The reference frankfurters in the taste tests were irradiated to 2.01×10^6 rep at an intensity of 1.68×10^6 r/hour in 1 hour 12 minutes. For taste testing the incomplete block design permitted the inclusion of a non-irradiated control sample which had been kept frozen until thawed for taste testing without heating above room temperature. The adjusted mean score for each treatment is given in Table 6.

Analysis of variance disclosed that the score for the control was significantly higher than for any of the irradiated samples. There were no significant differences among the packaging variables or between the frozen and unfrozen samples.

In another series of taste tests the samples were identical to those used in the previous frankfurter test but they were thoroughly heated in boiling water before serving. The adjusted mean scores from the incomplete block design for each of the treatments and the non-irradiated frozen control are given in Table 7.

TABLE 6

Adjusted mean flavor scores of frankfurters canned in air, vacuum, or nitrogen and irradiated to 1.98×10^6 rep while frozen or unfrozen. Tasted at room temperature

	Unfrozen			Frozen		
Control (Non-Irradiated)	Air	Vacuum	Nitrogen	Air	Vacuum	Nitrogen
3.74	3.28	3.16	3.23	3.29	2.97	3.16

L. S. D. $(0.05) = 0.34$.

TABLE 7

Adjusted mean flavor scores of frankfurters canned in air, vacuum, or nitrogen and irradiated to 1.98×10^6 rep while frozen or unfrozen. Tasted after warming

	Unfrozen			Frozen		
Control (Non-Irradiated)	Air	Vacuum	Nitrogen	Air	Vacuum	Nitrogen
4.44	3.20	3.78	3.56	3.44	3.27	3.09

L. S. D. $(0.05) = 0.29$.

Among the samples irradiated while unfrozen the frankfurters packaged in air had significantly more radiation flavor than those packaged in vacuum or nitrogen. There was no significant difference between vacuum and nitrogen packaging when the product was irradiated in the unfrozen state. When the sample was irradiated in the frozen condition, air packaging scored significantly higher than nitrogen packaging, but no significant difference could be demonstrated between vacuum or nitrogen treatments or between air and vacuum treatment. The non-irradiated control sample scored significantly higher than any of the treatments.

Separate analyses were made of the performance of each of the 11 tasters. It was found that 6 were unable to differentiate between any of the treatments, including the control. Three tasters found significant differences between the control and the treatments but were not able to differentiate between treatments. Two tasters not only found significant differences between the control and the 6 treatments but also among the 6 treatments. They did not agree completely in respect to the 6 treatments, but there was some degree of consistency for several of the treatments. Despite the discrepancy in tasters' judgments, they did agree to the extent of the means shown in Table 7.

When tasted at room temperature, bologna gave the results shown in Table 8. The bologna had been irradiated to 1.98×10^6 rep using a gamma flux at 6.6×10^6 r/hour for 18 minutes. The reference was irradiated to 2.01×10^6 rep with a gamma flux at 1.68×10^6 r/hour for 1 hour and 12 minutes. The control was a non-irradiated air-packed frozen sample.

TABLE 8

Adjusted mean flavor scores of bologna canned in air, vacuum, or nitrogen and irradiated to 2×10^6 rep while frozen or unfrozen. Tasted at room temperature

	Unfrozen			Frozen		
Control (Non-Irradiated)	Air (1)	Vacuum (2)	Nitrogen (3)	Air (4)	Vacuum (5)	Nitrogen (6)
4.54	3.62	3.47	3.31	3.32	3.24	3.54

Over-all analysis of variance of means among all tasters showed a significant difference between the non-irradiated control and the irradiated bologna, but no differences among the 6 irradiated treatments.

Further analyses of the performance of the 11 individual tasters disclosed that 4 tasters could find no significant difference among the treatments, including the control. Five tasters found a significant difference between the control and the 6 treatments,

but no significant differences among the 6 treatments. Two tasters not only found a significant difference between the control and the treatments, but also found significant differences among the 6 treatments themselves. In comparing the means for the 6 treatments scored by these 2 tasters, it was quite obvious that they did not agree with each other.

Probably the most significant flavor difference between irradiated and non-irradiated bologna was the reduction of spice flavor in the irradiated samples.

It is of interest that when the cans of irradiated bologna were opened, the surfaces not covered by casing had a slightly bleached appearance. Color difference measurements were made with the Hunter Meter on this surface and on the interior of the bologna and these converted *(1)* to Munsell Notations with the following results:

	Exposed surface	Interior surface
Treatment No. 1[4]	5.88YR 5.43/5.60	5.80YR 5.36/5.72
Treatment No. 2	5.35YR 5.30/5.68	5.21YR 5.43/6.00
Treatment No. 3	7.65YR 5.49/5.70	5.71YR 5.50/6.00
Treatment No. 4	7.59YR 5.68/5.86	4.76YR 5.52/6.02
Treatment No. 5	4.73YR 5.32/5.54	4.45YR 5.27/5.63
Treatment No. 6	6.89YR 5.64/5.60	4.44YR 5.42/6.32
Control	4.49YR 5.36/5.60	4.18YR 5.52/6.00

[4] Treatment numbers refer to those in Table 8.

It is evident from these results that although the interior color of irradiated bologna appeared "typical," differences between bologna subjected to the treatments and irradiated in the unfrozen state (1-3) and frozen state (4-6) were evident. The interior color of the latter more closely resembled the color of the unirradiated control. The interior color of the bologna irradiated in the unfrozen state was more bleached as compared with the control or the bologna irradiated while frozen.

Observations on the exposed surfaces were quite varied. It is interesting that in treatments 3 and 4, the surface of the bologna resting against the enameled end was somewhat "yellowed" as indicated by the high hue value. From a practical standpoint, there appeared to be little difference in the color of any of the samples when sliced and prepared for serving.

EXPERIMENTAL RESULTS OF OBJECTIVE 3

(a) Ground beef was irradiated in the frozen or unfrozen state to determine the effect of temperature of the product at the time of irradiation on the development of radiation flavor. In this experiment, the raw meat was canned in air. Half of the cans were frozen as above, the remainder chilled to water ice temperature. Non-irradiated control samples were shipped to and from Arco in either dry ice or water ice as companions to the irradiated samples. At Arco, the controls were kept under the respective temperature conditions while the experimental cans were irradiated for 27 minutes using a flux of 4.49×10^6 r/hr. to a dosage of 2.2×10^6 rep. A complete block design with 4 replications was used for a 10-judge taste panel evaluation. The results are given in Table 9.

TABLE 9

Mean flavor scores of ground beef irradiated to 2.2×10^6 rep while frozen or unfrozen

Unfrozen		Frozen	
Non-irradiated	Irradiated	Non-irradiated	Irradiated
4.48	2.85	4.35	3.36

L. S. D. (.05) = 0.57.

Inspection of these data shows that temperature at time of irradiation had no influence upon the development of irradiated flavor in ground beef. However, mean flavor scores for irradiated ground beef were significantly lower than those of the non-irradiated controls, irrespective of the product temperatures at time of the irradiation.

(b) Ground pork was tested similarly except that the product was returned from the radiation source packed in dry ice and was held at 0° F. in Corvallis until taste tested. All irradiated samples received a gamma ray dose of 2.02×10^6 rep (5.28×10^6 r/hr. for 23 minutes). Results are given in Table 10.

Inspection of these data shows that the taste panel was unable to detect a significant flavor difference between irradiated and non-irradiated ground pork. This result differs from that obtained with ground beef.

TABLE 10

Mean flavor scores of ground pork irradiated to 2.02×10^6 rep while frozen or unfrozen

Irradiated Unfrozen	Irradiated Frozen	Non-irradiated control
3.45	3.42	3.76

L. S. D. (.05) = 0.40.

(c) Frankfurters and bologna also were irradiated in the frozen and unfrozen states, as indicated above. Results showed that freezing was not effective for bologna. With frankfurters the situation is not clear. However, the data seem to show that when the frankfurters were packed in air, freezing had a favorable influence, whereas, if they were packed in vacuum or nitrogen, it was more favorable to irradiate the product in the unfrozen state. This situation needs further study.

EXPERIMENTAL RESULTS FOR OBJECTIVE 4

(a) The effectiveness of certain pre-irradiation treatments, principally those involving heating and dehydration, on the development of radiation flavor of ground beef was determined for the treatments singly and in combinations. The single treatments were partial cooking, complete cooking, and dehydration. Dehydration was combined with both partial and complete cooking.

Since the results above had shown that packing in vacuum or nitrogen gave no advantages flavorwise over packaging in air, the results reported in this section were derived from only the air-packed products.

Partial cooking was accomplished by broiling patties in the broiler of a gas stove. The meat was cooked for 4 minutes on each side. Complete cooking was accomplished in the same manner, except that the time was increased to 7.5–8 minutes on each side.

Dehydration was applied to both the partially and completely cooked ground beef. The meat was subdivided and spread on drying trays at the rate of one pound per square foot. Drying was at 156° F. dry bulb and 110° wet bulb in a forced draft dehydrator. Pertinent information regarding the moisture content of the beef follows:

	Partial cooking	Complete cooking
Before broiling	64.90%	61.85%
After broiling	56.57%	15.45%
After dehydration	5.73%	14.87%
Dehydration time	2 hours	3.75 hours

All test samples were irradiated for 18 minutes with a gamma flux of 6.6×10^6 r/hr. to produce a dosage of 1.98×10^6 rep. The reference sample was irradiated for one hour and 12 minutes with a gamma flux of 1.68×10^6 r/hr. to produce a dosage of 2.01×10^6 rep.

Mean flavor scores for the various treatments are shown in Table 11.

Analysis of variance of the incomplete block design showed a significant difference between certain pre-irradiation treatments. Those pre-treatments showing the least effect of irradiation, or seemingly the greatest protection from irradiation, were complete cooking and partial cooking combined with dehydration. However, in neither instance was the flavor score significantly different from that of ground beef irradiated in the uncooked state.

(b) Ground pork was handled and treated in a manner almost identical with that accorded ground beef to determine the effectiveness of pre-irradiation treatments in influencing the radiation flavor. Partial and complete cooking was accomplished

TABLE 11
Effect of pre-irradiation treatment on the flavor of irradiated ground beef

Treatment	Mean flavor score
Uncooked, unfrozen	3.79
Uncooked, frozen	3.52
Partial cook, unfrozen	3.30
Partial cook, frozen	3.37
Partial cook, dehydrated, unfrozen	3.66
Partial cook, dehydrated, frozen	3.74
Complete cook, unfrozen	3.65
Complete cook, frozen	3.74
Complete cook, dehydrated, unfrozen	3.52
Complete cook, dehydrated, frozen	3.42

L. S. D. (0.05) = 0.29.

exactly as for ground beef. Dehydration was conducted in a slightly different atmosphere. The dry bulb and wet bulb temperatures within the dehydrator were 165° F. and 120° F., respectively. Drying required approximately 3½ hours. There was considerable loss of fat from the pork during cooking and dehydration. This fat was discarded.

The pre-treated pork was canned in air, vacuum, or nitrogen and shipped to Arco in either dry ice or water ice. The cans were irradiated either frozen or unfrozen, as shipped, and then returned to Corvallis in their respective conditions. Upon return, they were all placed at 0° F. until thawed for taste testing.

A gamma radiation dose of 2.02×10^6 rep was applied to each can (5.28×10^6 r/hr. for 23 minutes).

For taste testing, the samples were warmed and served just as the respective samples of ground beef had been. Mean flavor scores are shown in Table 12 for the ground pork canned in air.

TABLE 12
Effect of pre-irradiation treatment on the flavor of irradiated ground pork

Treatment	Mean flavor score
Uncooked, unfrozen	3.45
Uncooked, frozen	3.42
Partial cook, unfrozen	2.90
Partial cook, frozen	3.31
Partial cook, dehydrated, unfrozen	3.31
Partial cook, dehydrated, frozen	2.86
Complete cook, unfrozen	2.98
Complete cook, frozen	2.98
Complete cook, dehydrated, unfrozen	3.09
Complete cook, dehydrated, frozen	3.09
Non-irradiated control	3.76

L. S. D. (0.05) = 0.41 control vs. treatments.
= 0.47 between treatments.

Analysis of variance showed that the principal effect, an unfavorable effect, of the pre-irradiation treatments on radiation flavor of ground pork was due entirely to cooking. Samples irradiated in the uncooked condition had significantly less radiation flavor than those irradiated after partial or complete cooking. As a matter of fact, the experienced tasters were unable to distinguish between the non-irradiated control and the ground pork which had been irradiated in the uncooked state either frozen or unfrozen.

FLAVOR ACCEPTANCE STUDY

In view of the inability of experienced tasters to distinguish between non-irradiated ground pork and pork irradiated in the uncooked state, it was desirable to determine the reactions of tasters who had had no previous experience with radiation flavor in either ground beef or pork.

Ground beef was canned in air and frozen at —20° F. Half of the cans was sent to the radiation source packed in dry ice. They were irradiated in a flux of 1.69×10^6 r/hr. for 1 hour and 12 minutes to a total dosage of 2.02×10^6 rep while in the frozen state. The remaining half of the cans was kept in Corvallis at 0° F. The irradiated cans were shipped in dry ice to Corvallis and on arrival were stored 2 weeks at 0° F. until used for taste testing.

Fresh ground pork (60% lean, 40% fat, with no added seasoning) was canned in air and handled in a manner identical to the ground beef except that the cans were irradiated in a flux of 5.28×10^6 r/hr. for 23 minutes to a total dosage of 2.02×10^6 rep while in the frozen state.

For tasting, the ground beef and pork were formed into patties and broiled 4 minutes on each side. Samples were served in paper serving cups coded with 3 digit numbers taken from a random number table. Each taster scored 2 samples at a sitting. A third sample cup was marked with an "R" and contained the reference sample, which in this instance was a non-irradiated sample.

The panel for this study was composed of 112 tasters who had no previous experience with irradiated meat. Each taster made his judgments in an isolated booth lighted by an amber light to minimize prejudices from possible color differences in the samples.

A 9-point hedonic scale ballot with the reference pegged at 5, was used for scoring the samples. Nine points were equivalent to *like extremely* while 1 point was equivalent to *dislike extremely*.

Statistical analysis of the results of this experiment (Table 13) showed a highly significant difference in preference between the irradiated and non-irradiated samples of ground beef and ground pork. This difference was in favor of the non-irradiated sample in both cases.

TABLE 13
Mean flavor acceptance scores by 112 persons tasting irradiated and non-irradiated ground beef and ground pork

	Non-irradiated	Irradiated	Difference
Ground Beef	5.75	5.18	0.57**
Ground Pork	5.82	4.65	1.16**

** Significant.

The explanation for the different responses of the experienced and inexperienced tasters may lie in the possibility that the radiation flavor, as present in meat, particularly pork, may be such that one can become accustomed to it over a period of time.

SUMMARY AND CONCLUSIONS

The attractiveness of using ionizing radiations to preserve meat and meat products warrants extensive, careful examination of all factors pertaining to the procedure. In an effort to help solve the problem of eliminating or minimizing the development of radiation flavor in meat subjected to radiations, a number of methods of treating the meat before subjecting it to gamma radiation and a number of conditions under which the meat can be held during the irradiation have been examined.

On the basis of the studies with gamma rays reported here, it is possible to conclude that under the conditions of the experiments:

1. Irradiation dosages from 124,200 to 993,600 rep show a linear relationship between irradiation dosage and intensity of radiation flavor of ground beef. On a 5-point scale of radiation flavor intensity each doubling of dosage was found to reduce the flavor intensity score (increase radiation flavor) by 0.225 points. A dosage of only 124,200 rep may produce a flavor different from that of non-irradiated ground beef.

2. The intensity of the source of gamma rays used in treating ground beef and the length of time needed to achieve a dosage of 2×10^6 rep has no effect on the extent of the development of radiation flavor, within the limits of this experiment.

3. There was no significant difference in the intensity of radiation flavor produced in meat canned in atmospheres of air, vacuum, or nitrogen. A possible exception exists in the case of frankfurters.

4. There was no significant difference in the intensity of radiation flavor between meats irradiated while in the frozen or unfrozen state.

5. There was no significant difference in the intensity of radiation flavor of ground beef or pork as a result of pretreating with partial or complete cooking, with or without dehydration, as compared to these meats which were not so pretreated. Combining heat treatment or dehydration with irradiation did not reduce the production of radiation flavor; it may actually intensify it.

6. Experienced tasters were unable to detect a significant difference in the flavor of non-irradiated ground pork and pork irradiated with a gamma ray dosage of 2×10^6 rep. However, a panel of 112 persons inexperienced with radiation flavor found significant differences in both ground beef and pork. These results suggest that the radiation flavor is one which persons may become accustomed to without dislike if tasted over a period of time.

Acknowledgment

The authors wish to acknowledge with thanks the meticulous manner in which Donald R. Alvord and his staff at the Materials Testing Reactor, Phillips Petroleum Co., Arco, Idaho, irradiated and handled the samples used in these studies.

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The Discernment of Primary Tastes in the Presence of Different Food Textures[a]

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Texture differences in foods are important in influencing preference but the part that texture may play in perception of taste is unknown. In the study herewith reported three food textures, liquid, gel, and foam were investigated in relation to their effect on taste perceptibility of sweet, sour, bitter, and salt substances.

Crocker *(1)* has suggested that the physical state of a food may affect its taste since texture may partially control the sapid matter that reaches the taste buds in a given time. A thin liquid will seem weaker in taste if a thickening agent is added. This may be due to interference with diffusion of soluble substances. Lowe *(3)* has suggested that food foams may require extra flavoring due to the dilution effect of incorporated air. Although the premise seems sound that texture may alter taste perception, no work has been reported in which this has been subjected to a planned investigation.

Values found in the literature for the perception of taste substances are usually based on water solutions of these substances without respect to any other materials present. In the case of sugars, the relative values for sweetness are usually given as 100 for sucrose and 74 for dextrose when these substances are in water solution. However, Fabian *(2)* notes that, when added to foods or beverages, the comparative sweetness of different sugars changes according to the food product. Mackey *(4)*, in studying the validity of judgments for taste substances in water as compared with food, found that detection of taste substances in foods differed from detection of the same substances in water. These differences in taste perception when food is the vehicle rather than water may be due to the presence of naturally occurring taste and flavor substances. They may be influenced also by the texture of the foods used.

In food preparation a multitude of texture differences occur. In addition to variations due to kinds of ingredients, texture of a given food will depend on degree of mixing, order of combining ingredients, period of time during which heat is applied and other factors.

Liquids, gels, and foams constitute a group of textures that can be produced in foods without varying the ingredients. It might be expected that the diffusion rate of water-soluble substances would be faster in a liquid than in a gel—thus making taste perception easier in liquids. Yet in a gel, the dispersion medium is liquid. A gel, though rigid before tasting, might melt when crushed in the mouth during the tasting process, or might give up its liquid matrix with such ease that taste perception would be little influenced by the fact that the food originally possessed a gel structure.

[a] Contribution from the Oregon Agricultural Experiment Station.
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PROCEDURE

In selecting foods for testing the effect of texture on taste perception, the considerations were: the food should be homogeneous; several texture variations should be possible with the same ingredients and at the same serving temperature; texture variations should be normal ones for the food; if possible, the foods selected should not themselves be distinctly acid, sweet, bitter or salt. In making final decisions as to specific foods to use, it was necessary to subordinate the last-mentioned consideration, since the distinguishing characteristics of foods include some sweetness, sourness, saltiness, or bitterness, or combinations of these primary tastes.

Two foods were chosen as a basis for texture variations. They were tomato juice and a milk-egg custard, each with added gelatin. Both foods could be prepared as a liquid, gel, or foam without changing the ingredients or their proportions. The taste substances added to the foods were sodium chloride, tartaric acid, sucrose, and caffeine. They were used at low levels. The concentrations of taste substances used in the foods are shown in Table 1.

The basic recipe was prepared in sufficient quantity for all texture and taste variations. To a measured portion of the prepared recipe, a weighed amount of the test substance was added. Each of these portions was then prepared as liquid, gel, and foam. The tomato foam was beaten until double in volume to establish similarity in volume between the custard foam and tomato foam.

There were 10 judges. The triangular method of testing was used. Each judge was served 3 samples, two of which contained no added taste substance, the remaining sample containing the test substance. Gel, foam, and liquid textures were randomized at each level of test substance. Three replications at this level were judged before samples containing a higher level of test substance were introduced. When necessary, lower levels were then tested to establish thresholds for each judge. The analysis of variance was used for testing the significance of differences due to textures, foods, taste substances, and judges. In the analysis of variance, the number of judgments correct at each level of added taste substance were used for analysis. For this analysis, levels 3, 4, 5, 6, and 7 as shown in Table 1 were used, plus level 2 for sucrose. The lower levels shown in Table 1 were included for the purpose of establishing threshold values for these substances in foods.

Thresholds for taste substances in water were compared with thresholds for foods by using the level of added constituent at which 67 percent of the judgments were correct. The 67 percent point was found by interpolation. The concentration of taste substances used in water solution are shown in Table 2.

TABLE 2

Molar concentration of chemicals used in distilled water

Concentration number	Tartaric acid	Sucrose	Caffeine	Sodium chloride
1	0.0000325	0.00125	0.00013	0.000313
2	0.000065	0.00250	0.00025	0.000625
3	0.000130	0.00500	0.00050	0.001250
4	0.000250	0.01000	0.00100	0.002500
5	0.000500	0.02000	0.00200	0.005000
6	0.001000	.....	.....	0.010000

TABLE 3

Analysis of variance of discernment of taste substances. The analysis is based on the number of correct judgments at each level of added taste substance

Source of variance	Degrees of freedom		Mean square			
	Tartaric acid, sodium chloride and caffeine	Sucrose	Sucrose	Tartaric acid	Sodium chloride	Caffeine
Total	299	359	.....	.....	.....	.....
Food	1	1	39.3362**	7.0534**	35.3634**	13.2300**
Texture	2	2	1.8778*	2.1234**	2.1234**	.3034
Level	4	5	12.5828**	18.8367**	18.7884**	8.8834**
Judge	9	9	4.5867**	2.9793**	1.0819**	2.4982**
Food x texture	2	2	.8110	1.2233	.9633	.0100
Food x level	4	5	.4894	.7200	3.0216**	1.0633**
Texture x level	8	10	.3611	.7442	.3983	.1033
Food x texture x level	8	10	.7344	.7275	.6717	.0933
Food x judge	9	9	.6880	1.4533	.7707	.8300**
Texture x judge	18	18	.8066	.5937	.3196	.1959
Level x judge	36	45	.4704	.6070	.5254	.5111**
Remainder	198	243	.4916	.4503	.4089	.2920

**Significant at the 1% level.
*Significant at the 5% level.

RESULTS AND DISCUSSION

Results as determined by means of the analysis of variance, Table 3, were: the detection of added taste substances was different for the two foods, was affected by texture of the food, was affected by level of constituents added, and was different for different judges.

At each level of added taste constituent, regardless of texture, sodium chloride, sucrose and caffeine were more easily detected in the custard than in tomato. The added sour substance, tartaric acid, was easier to detect in tomato. This was probably due to the buffering action of milk and egg proteins which would tend to mask added acid in the custard. The number of judgments that were correct at each concentration of taste substance are shown in Table 4.

Texture of the food—i.e., liquid, gel, or foam—affected ease of discernment of added sweet, sour and salt substances, but not of bitter. This may have been due to the delay and lingering effect characteristic of the bitter taste.

Totals of correct judgments for each texture show that added taste substances were easiest to detect in the liquid state, hardest in the gel, and intermediate in the

TABLE 1

Molar concentration of chemicals used in foods

Concentration number	Tartaric acid		Sucrose		Caffeine		Sodium chloride	
	Tomato juice	Custard	Tomato juice	Custard	Tomato juice	Custard	Tomato juice	Custard
1	.....	.....	.....	.0025	.....	.....	.....	.....
2	.....	.....	.0050	.0050	.....	.0005	.....	.00125
3	.0005	.0005	.0075	.0075	.0010	.0010	.0025	.0025
4	.0010	.0010	.0100	.0100	.0020	.0020	.0050	.0050
5	.0020	.0020	.0125	.0125	.0030	.0030	.0100	.0100
6	.0030	.0030	.0150	.0150	.0040	.0040	.0200	.0200
7	.0040	.0040	.0175	.0175	.0050	.0050	.0300	.0300

TABLE 4

Number of judgments correct* at each concentration of added taste substance

Taste substance	Moles per liter	Water	Foods					
			Liquid		Gel		Foam	
			Tomato	Custard	Tomato	Custard	Tomato	Custard
Tartaric acid	.0000325	4	—	—	—	—	—	—
	.000065	9	—	—	—	—	—	—
	.00013	15	—	—	—	—	—	—
	.00025	24	—	—	—	—	—	—
	.0005	29	16	13	15	15	21	11
	.001	30	25	19	14	17	22	20
	.002	—	28	25	24	21	28	15
	.003	—	30	29	29	27	27	25
	.004	—	30	29	28	25	29	29
Sucrose	.00125	12	—	—	—	—	—	—
	.0025	16	—	—	—	—	—	—
	.005	17	10	17	12	15	13	18
	.0075	—	19	26	16	26	17	29
	.01	27	22	29	19	27	26	27
	.0125	—	26	27	12	28	22	28
	.0150	—	21	29	21	28	22	27
	.0175	—	27	30	23	30	24	30
	.02	30	—	—	—	—	—	—
Caffeine	.00013	4	—	—	—	—	—	—
	.00025	21	—	—	—	—	—	—
	.0005	21	—	22	—	16	—	17
	.001	23	17	25	15	24	15	21
	.002	30	23	30	23	28	24	30
	.003	—	28	30	28	29	27	30
	.004	—	27	29	25	30	25	30
	.005	—	29	30	28	29	27	29
Sodium chloride	.000313	1	—	—	—	—	—	—
	.000625	12	—	—	—	—	—	—
	.00125	21	—	17	—	9	—	17
	.0025	22	14	22	4	25	10	20
	.005	29	18	26	13	22	16	24
	.01	30	25	30	20	27	16	28
	.02	—	28	29	27	30	24	30
	.03	—	29	30	30	30	26	30

*Possible 30.

foam. This was true at each level of taste constituent. The most noticeable differences due to texture variation were in the tomato series although the custard series showed similar trends in less degree.

When analyzed by individual taste substance, the greater ease of detection in liquid as contrasted with gel was apparent. However, the relative position of the foams varied. The detection of the salt taste in foams was similar to its detection in gels whereas the sweet taste was as easy to detect in foams as in liquid. In custard, the sour taste was less discernible in foams than in gels. If the foams had been lighter, differences due to this texture would undoubtedly have been more pronounced. It was not possible to prepare a light foam with the custard base used in this experiment.

Threshold values for taste substances in foods are shown with threshold values for water solutions in Table 5. Thresholds of taste were lower for water solutions than for the same substances in foods.

TABLE 5

Molar concentration of added sweet, sour, salt and bitter substances at which 67% of judgments were correct

Taste substance	Water	Foods (liquid only)	Foods (liquid, gel and foam)
Tartaric acid	.000187	.00085	.00113
Sucrose	.0063	.00655	.00655
Caffeine	.000485	.00095	.0011
Sodium chloride	.0012	.00375	.0052

SUMMARY

The possibility that food texture may affect discernment of taste substances was investigated. By means of the triangle test, and using 12 judges, the levels at which primary taste substances (sodium chloride, sucrose, tartaric acid, and caffeine) could be detected were determined in water solutions and in two foods which were prepared as liquid, gel and foam.

Threshold values were found to be lower for taste substances in water solution than for the same substances added to foods. At the levels tested, the added taste materials were harder to detect in foods prepared as gels than in the corresponding liquids. Foams tended to be intermediate, but were not distinctly different from liquids or gels.

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REGIONAL SECTIONS

(Continued from page 36 preceding technical papers)

carbohydrate and protein systems. In general, the chemical nature and origin of the off-flavor components are not yet known. From a practical standpoint, free

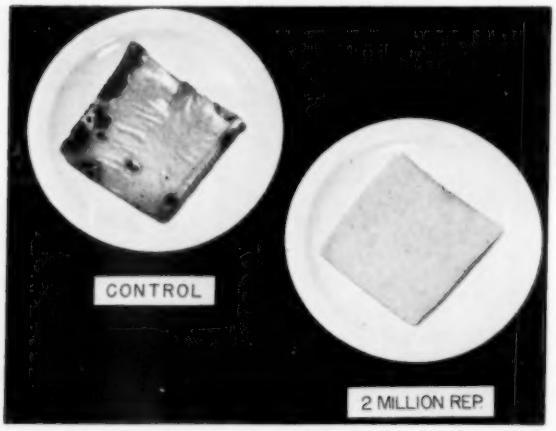

Figure 3. Cheese—the mold doesn't get started.

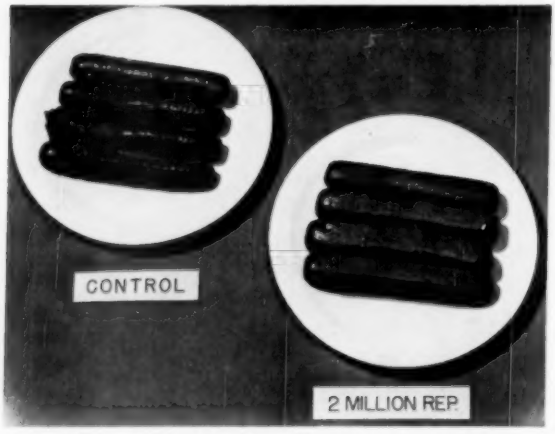

Figure 4. Frankfurters—the contrast is notable.

radical acceptors have minimized off-flavor production in several foods.

$$\text{Flavor Molecule} + OH^{\cdot} \text{ ------ Oxidized Off-Flavor} + OH^{-}$$

$$\text{Flavor Molecule} + OH^{\cdot} + \text{F.R.A.} \text{ ------ Flavor Molecule} + OH^{-} + \text{FRA (oxidized)}$$

(free-radical acceptor)

Proctor and Goldblith *(7)* were successful in eliminating off-flavors in several foods by adding free-radical acceptors to the product prior to irradiation. Huber, Brasch and Waly *(8)* describe a number of protective methods to control quality characteristics of foods being irradiated such as irradiation in the frozen state, in vacuum, under inert gas, in the presence of various chemicals, with the elimination of oxygen dissolved in the foodstuff prior to irradiation, and combinations of these treatments. The chances of overcoming this problem are further encouraged by the fact that some foods are not significantly affected by levels of radiation necessary for sterilization. Also, the same degree of off-flavor is not consistently produced in the same foods, i.e., meat, a typical example.

An important factor in the evaluation of a new process for food preservation is its effect on food nutrients. Some sacrifices are made in all types of food preparation and processing. The same must be true for radiation treatment. Significant losses of some of the vitamins have been reported upon the irradiation of foods at sterilization dosages but the same techniques developed to overcome the off-flavor problem also yield higher vitamin retention. In a study of the effects of sterilization dosages of irradiation on milk, beef, beans and peas, B. Conner Johnson *(9)* has reported no more effect on the nutritive value of proteins than occurs during heat sterilization.

The problem of the minimum sterilization dose for the production of commercially sterile and safe foods has yet to be accurately determined. There are specific environmental effects of the food on the resistance of bacteria to irradiation. In addition, variations in radiation resistance have been observed on some strains of the same bacteria and some highly resistant strains have been observed. Considerable work is underway to determine the minimum dose for destruction of *Clostridium botulinum*, the organism on which safe thermal processes for non-acid foods are based.

The prospects. With the rapid research advances which are being made, the answers on most of the problems on radiation treatment of foods, so far as its practical aspects are concerned, should be available in the next few years. There is every indication that the results will be encouraging. Although irradiation sources may seem to be a problem, authorities say this can be resolved in an economically satisfactory manner if there is sufficient potential demand.

From present accomplishments, it appears that the treatment of foods by radiations will express itself first in the form of combination treatments, complementing rather than replacing present conventional processes such as canning, refrigeration or dehydration. As has been stated, considerable evidence is available to show that the irradiation of pre-packaged meat at low dosages extends refrigeration shelf life five to twenty times. In further pursuit of the finding of Morgan and Reed *(10)*, Kempe *(11)* has recently confirmed that pre-irradiation lowers the resistance of some bacterial spores to the lethal action of heat. For *Clostridium botulinum* spores, pre-irradiation at less than one million rep reduced the Fo value approximately fourfold. The possibilities offered here for combination treatments for heat sensitive foods are very encouraging. Antibiotics have recently made an official entree into commercial food preservation. With their known spectrum of biostatic action for specific food spoilage bacteria, antibiotics may

also have an important place in combination treatments for food preservation in the future. In fact, when one considers the possible combinations of heat, refrigeration, dehydration, antibiotics and radiation which may give more effective preservation to specific food commodities, the only conclusion can be that the surface has only been scratched.

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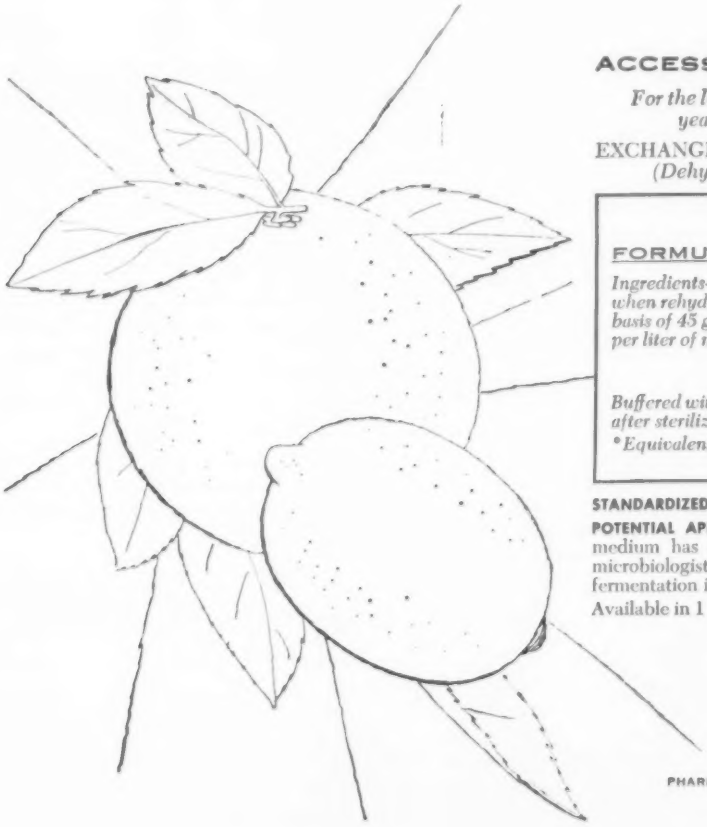
NORTHERN CALIFORNIA . . . .

Beginning with the February meeting, Co-Program Chairmen Maynard Joslyn and Carl Havighorst have been presenting a series of programs on aspects of management of interest to Food Technologists.

Douglas Watson, of the firm McKinsey and Gordon, Management consultants of San Francisco, first speaker in the series, told an audience of one hundred that the reason sales-graduated executives dominate the food industry while technical-graduated executives dominate the chemical industry is that success in chemical manufacture has depended upon technical progress while success in the food industry has been proportionate to the ability to compete in price, yield and promotion.

With the increasing importance of prepared specialty foods the picture is changing somewhat but there are major problems to be solved. Products must be introduced and sold to individual consumers. Large supermarkets are reluctant to give shelf space to new products until a demand is created and a demand cannot be established until consumers try the products. Again major



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Section Chairman Bruno Grossi received brief reports from Section Committee Chairmen. Members were keenly interested in plans for the 1960 National Meeting in San Francisco.

NORTHEAST . . . .

The Section held its March 1st meeting in commemoration of the 50th anniversary of the signing of the Federal Food and Drugs Act of 1906.

Ninety-four members and guests turned out to hear Mr. John L. Harvey, Deputy Commissioner of the Food and Drug Administration, give an excellent and timely presentation of the various bills before Congress concerning food additives. These bills deal with the problem of safety to the consumer arising from the widespread and increasing use of chemicals in modern food processing technology.

Under existing law, no action can be taken by the Food and Drug Administration to stop the use of a chemical until they can prove that it actually is a poisonous or deleterious substance. All pending legislation emphasizes that the burden of proof as to safety be borne by the person offering the chemical for food use. The F. D. A. is strongly in accord with this objective, but favors amending certain parts of the bills in order to achieve the desired protection. One such recommendation would require that a known poison, even in apparently safe amounts, be permitted only when it has been established that it has a functional value in the food in question and cannot be replaced by a substance or processing method of known safety. A second recommendation deals with the so-called blanket "grandfather clause" which would put the approval seal of Congress on the continued use of chemicals of questionable safety introduced prior to enactment of legislation. The Food and Drug people believe that this clause should exempt only those additives already sanctioned by them. "A law that is difficult to enforce would not be consistent with public interest" states Mr. Harvey. Therefore, his department strongly opposes both the declaratory judgment approach and the injunction procedure, which would allow a manufacturer of a disallowed chemical to continue shipment after a temporary injunction and to eventually reopen the case in a District Court. It is the contention of the Food and Drug Administration that scientific assessment of such matters as public safety vs. chemical additives is not within the trained scope of the law.

MARYLAND . . . .

The Section held its March meeting on Friday, March 9. This was a joint meeting with the American Society for Quality Control and Dr. Howard L. Stier of the National Canners Association was the speaker.

Dr. Stier discussed the results of a recent survey which investigated the application of statistical quality control in the canning and preserving industry. He pointed out the difficulty in applying methods of statistical quality control to food, due to the inherent variability of biological material and the difficulty of objective evaluation of quality attributes. He defined statistical control as the use of statistical processes to determine whether variability is due to chance or inherent causes or springs from definite controllable factors, called, in the jargon of the field, "assignable causes." He mentioned some of the unlikely uses of these techniques. For example, United Airlines uses them in maintenance, in reservation control and provisioning. Dr. Stier also showed a series of slides describing the degree of use of quality control in the preserving and canning industry, why various firms have used it or not used it, and examples of its use and accomplishments. Further, he considered and commented on the objections to statistical quality control and the qualifications and applications of it advanced by some of its users. In particular, he alluded to its use in avoiding the disadvantages of overcontrol. In conclusion, he pointed out that he felt it was best applied, not by the expert in statistics, but by the person with a thorough understanding of the basic situation to be controlled.

Following Dr. Stier's talk, there was a lively discussion revolving, in part, about the differences in applying statistical quality control to the food industry and to other manufacturing problems.

BUFFALO . . . .

Guest speaker for the last Buffalo IFT meeting of the 1955-56 term was Mr. Ivan Miller, Associate Editor of *Food Engineering*. His timely subject, "The Role of the Technologist in Management" assessed the opportunities available to the technologist who is interested in managerial duties. Both "big" and "small" businesses are looking now, even harder than ever, for top management talent. In order for the technical man to qualify he must interest himself in the various responsibilities of an administrator or coordinator. The meeting was well attended with new members from Rochester, Geneva, and other outlying communities.

The following officers were elected for 1957: Chairman, Mr. Fred Ziman; Board Members, Mr. Max Lynch, Mr. Francis Tolan, and Mr. Franklin Mesler.

DIXIE . . . .

The Dixie Section of the Institute of Food Technologists met Friday, March 30, in Macon, Georgia, to tour the Strietmann Biscuit Company Plant and Procter and Gamble's Refining and Hydrogenation Shortening Plant, and to hear a talk on "New Developments in Shortening" by Mr. William F. Schroeder of

(Continued on page 44)

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(Continued from page 42)

The HumKo Company, Memphis, Tennessee. Approximately 58 members and guests of the Section were in attendance. The Strietmann Biscuit Company Plant is one of the newest baking plants in the country and members of the Section enjoyed seeing the efficiency of operations in this plant as well as in the Procter and Gamble Plant. Mr. Schroeder pointed out that the vegetable shortening industry was one of the first of the food industries to develop as a result of fundamental chemical research and he pointed out how developments in vegetable shortenings have contributed to advancements in other food industries. Mr. Schroeder's talk was followed by numerous questions and discussions of the role of newer types of shortenings—both vegetable and animal—in improving the functional characteristics of foods containing fats.

PHILADELPHIA . . . .

On April 3, 1956, the Section met in the Faculty Club Room, Drexel Institute of Technology, 32nd and Chestnut Streets, Philadelphia, for dinner and a program entitled: "Federal Food and Drug Administration Activities." Theme of the presentation was "50 Years of Progress, 1906-1956." The papers began with "Recollections of Work with Dr. Harvey W. Wiley and the 'Poison Squad,'" by Clement Starr Brinton, retired. Mr. Brinton analyzed adulterated food samples for Pennsylvania authorities in the 1890's; was chemist with Dr. Harvey W. Wiley's Poison Squad investigators before 1906; was Chief of Philadelphia District until he retired in 1944. Other presentations were: "Philadelphia District, Food and Drug Administration," Robert C. Stanfill, Chief; "Inspections and Investigations," T. C. Maraviglia, Chief Inspector; "Analytical Facilities," Charles A. Wood, Chief Chemist; "Spectrophotometry," F. A. Rotondaro, Chemist; "Microanalysis," a demonstration by Manion M. Jackson, Chemist and Microanalyst; and "F. D. A. Technical Divisions," Norman Kramer, Bacteriologist.

Nominations for the Section officers for 1956-57 are as follows:

Chairman: E. C. Dryden
Vice-chairman: John Grimmins
Secretary: Norman Kramer
Treasurer: Fred Jacobson
Councilor: Rene Pouchain
Alternate Councilor: Richard Foster
Executive Committee: R. Mullan.

A Symposium on Instrumentation moderated by Mr. William J. Scarlett of Minneapolis-Honeywell Regulator Co. was the main event of the March meeting. The panel members and topics discussed were:

Mr. R. B. Reynolds, Taylor Instrument Co.—"Fundamentals of Measuring Systems."

Mr. L. M. Richardson, The Foxboro Co.—"What is Available for Process Control?"

Mr. T. Workman, General Electric Co.—"Applications of Radiation to the Food Industry."

Mr. E. J. Guilfoy, Radio Corporation of America—"Metal Detection in Food Products and Beer and Beverage Inspection."

The presentation was outstanding and well received by the members.

OHIO VALLEY . . . .

George Garnatz, President-Elect of the Institute of Food Technologists, acting in his official capacity as treasurer of the Finance Committee of the Ohio Valley Section Institute of Food Technologists, presents a check for $5000.00 to Kenyon S. Campbell, Field Director, The Ohio State University Development Fund as H. D. Brown, General Chairman of the 15th Annual Meeting, looks on.

Garnatz Brown Campbell

Interest ($300 annually) from the money which is deposited with the State of Ohio will be used as awards to undergraduate students in Food Technology who have made outstanding scholastic achievements.

The Committee on Awards consists of one member of the Ohio Valley Section, Institute of Food Technologists, The Director of Institute of Nutrition and Food Technology, and the Dean of the College of Agriculture of The Ohio State University.

OREGON . . . .

Dr. E. W. Harvey, Chairman of the Oregon Section, has become one of this country's F.A.O. Interim Committee members on Fish Handling and Processing. He reports a definite need for cooperation and dissemination of information in the field of fisheries among nations of the free world.

The Ernest H. Wiegand Award, presented annually by the joint efforts of the Oregon Section and the Stu-

(Continued on page 46)

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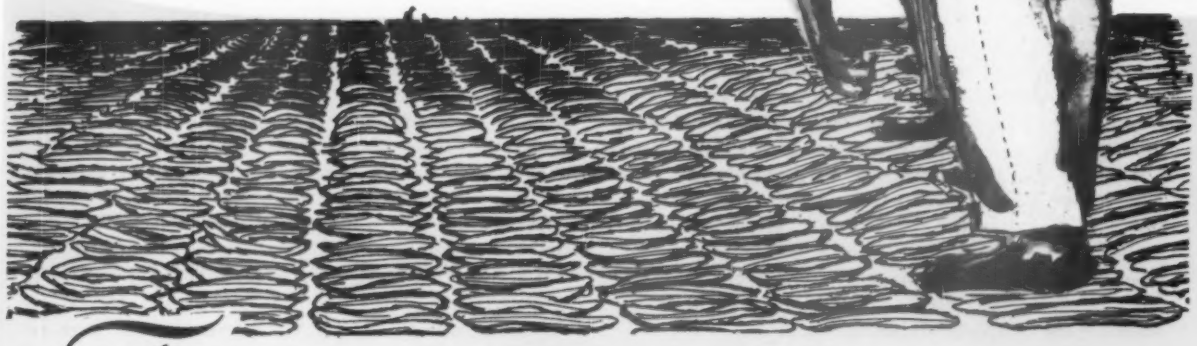

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(Continued from page 44)

dent chapter, will be presented this year to Robert E. Hughes, Jr., McMinnville, Oregon. This award is given to a senior student, and is based on grade point average, Food Technology grades, Food Technology activities and interest, leadership, character and professional potential.

TEXAS . . . .

The Texas Regional Section was indeed fortunate in having a "double-barrelled" program of speakers for its first meeting of the year in Houston on March 13. Our President, Dr. L. E. Clifcorn, gave a comprehensive picture of the chemicals in foods controversy as it looks today, and Dr. Paul Erlandson enlightened the 30 members present at the meeting with an interesting talk on energy conversion and its possibilities in the food industry.

Dr. Clifcorn vividly illustrated the complicated dilemma that the food industry and the Federal regulatory authorities face today in finding an equitable formula that will protect the consumer from possible deleterious chemicals in foods or food containers and which will at the same time not be impractical, ridiculous, and/or contradictory in its scope or intended purpose.

Dr. Erlandson explained the concept of considering all matter as being composed of force or energy. Some of the more commonly understood types of energy were mentioned, but it is obvious that some of the less commonly understood types of energy should become increasingly important in the future. Although the study of energy is more particularly the concern of the power producing departments in industry, the food technologist should be cognizant of the innovations that are materializing. After the transition has been made from the experimental to the practical, and plants have been set up to effect the harnessing of the atom, we can look forward to energy being almost as free and cheap as water and air, according to the views of Dr. Erlandson.

The speaker also described a "nutrino"—a particle of matter even smaller than the neutron, which had been considered the smallest particle until the nutrino was discovered. It seems that the sun emits these particles and they pass right through the earth. When knowledge of this nature becomes prevalent it will at least be interesting to watch its application through the imaginations of the cartoon artists and the producers of T. V. shows of the "Captain Midnight" variety.

It was especially enjoyable to hear a talk on this atomic energy subject in connection with food production and a future life of abundance, rather than the usual terrifying slant of Universal destruction from the concentrated energy of a bomb blast.

A humorous contrast was added to the Texas Section meeting through the impromptu remarks of Colonel Charles Lawrence, our Executive Secretary, who was visiting at the meeting. His "Army Bucket" story, in which a gravity insulator is used, was in keeping with the Texas atmosphere and seemed to relax the group.

The program was preceded by an enjoyable cocktail hour and steak dinner.

The next Texas Section meeting will be held on or about May 24, 1956, either in Houston or Sugar Land, Texas. The tentative plans call for a visit to the very modern Imperial Sugar Company plant, followed by a dinner and program. The latter will be announced in the very near future when plans have been completed. An invitation is extended to any IFT member who may be in the vicinity of Houston at that time.

CHICAGO . . . .

The April meeting of the Chicago Section was held April 9 at the Palmer House. Dr. Stephan S. Nesbit, public relations director for the Gerber Products Co., Fremont, Michigan was the speaker.

Dr. Nesbit's talk centered around the theme "everyone's public relations is determined by the way he does things." He pointed out that even though employes are the greatest single asset of a company, human resources are the least developed of all industrial resources. Industry must be responsive to the needs of its people and put their welfare first. According to Dr. Nisbet, the Big 4 desires of the average American are: 1, recognition; 2, opportunity; 3, security; 4, wages.

The March meeting was held at the Quartermaster Food and Container Institute, Chicago, Ill.; 191 members and guests enjoyed a delicious chicken dinner in the Quartermaster Corps cafeteria.

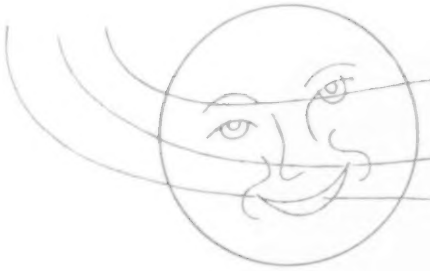
Col. Peterman welcomed the Section to the Institute. The members and guests broke up into small groups which toured the Institute's laboratories. This was an especially informative tour, some of the highlights of which were: Microbiology group, radiation sterilization, ration exhibits, packaging of materials and equipment, dehydro freezing of fruit juices, vegetables, meat and fish. A short movie was presented, along with exhibits of equipment, demonstrating the materials and methods used for protecting air drop shipments for the Armed Forces.

Following the tour of the Quartermaster's facilities, the members enjoyed a collation consisting of reconstituted dehydro frozen orange juice, and coffee with cakes and sweet rolls made from QM's dry mix formulations.

Chairman Mutschler expressed the appreciation of the Section to Miss Dorothy Ann Huber, Mr. V. O. Wodicka, and Col. John D. Peterman, who were responsible for the arrangements for the March meeting.

PERSONNEL

Charles G. Ferrari, technical director of the J. R. Short Milling Company of Chicago, Illinois, has been elected a vice president of the company. Dr. Ferrari was formerly director of Chemical Research at General Mills, Inc., and Assistant to the Vice President in Charge of Research at Standard Brands, Inc.



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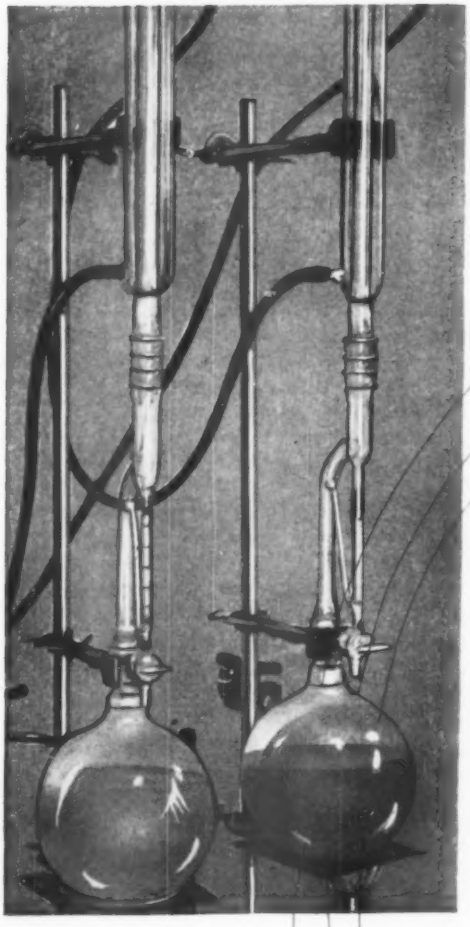

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FOOD INDUSTRY TOPICS . . .

. . . by Norb Leinen

. . . in the public interest

Establishment of a new Subcommittee on Protection from High Energy Electrons—to deal primarily with problems of protection against very high intensity electron radiation produced by accelerators—was announced by Mr. Lauriston S. Taylor, chief, Atomic and Radiation Physics Division, National Bureau of Standards, and chairman of the National Committee on Radiation Protection. Members will solicit data and prepare protection recommendations for installations where radiation-producing machines are used. Chairman of the group is Dr. Lester Skaggs, Argonne Cancer Research Hospital, Chicago.

◆ ◆ ◆

Mrs. Harvey W. Wiley, widow of the famous pure food and drug crusader, and Commissioner Geo. P. Larrick of the U. S. Food and Drug Administration, consider plans for celebration of the 50th Anniversary of the pure Food and Drugs Act of 1906, called the most significant peacetime legislation in the history of the country. They are examining the first copy of the "Food Work Kit" which will aid commemoration projects in all parts of the country during the year-long celebration.

◆ ◆ ◆

The tradition-bound dairy industry was pictured recently as lagging behind U. S. industry at large in technical development. Despite more than $43 million invested by the industry in new plants and equipment, the industry has generally been a "timid experimenter with the automatic control techniques which today form the backbone of industrial automation," according to IFT member W. J. Scarlett, food industry manager for Minneapolis-Honeywell's Industrial Division. He said it was significant that in terms of value added by manufacture, the food industry as a whole invests only about one-fourth as much as all industry in the basic "tools of automation"—the automatic industrial recording, sensing, and controlling devices. Mr. Scarlett said he saw many advancing stages of automation in scattered phases of dairy operations. Typical of these is use of electronic controls to aseptically can fresh whole milk; use of multi-point temperature instruments to monitor a number of milk storage tanks; and use of electronic measurement in production of butter, resulting in better flavor and longer shelf life.

◆ ◆ ◆

Competition is now open for the 1956 D&O Achievement Award, presented annually for outstanding contribution to the meat packing industry. The award consists of $1,000 and a gold medallion. Any individual or corporate member of the industry, either active or closely associated (except D&O employees) is eligible and may submit as many nominations as desired. Selection of recipient will be by a panel of six judges, and nominations may be made in all areas affecting the industry—research, operations, or engineering. For information on rules and regulations, write Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y.

◆ ◆ ◆

At a meeting sponsored jointly in San Antonio, Texas, March 15–16, by IFT and Southwest Research Institute, over 100 scientists heard presentations on the anticipated future role of food physics—the name given to that branch of the food industry technology which can be developed by physical methods. Previously, chemistry and chemical engineering have been the basis for food technology. Development of electronics and atomic energy present new opportunities to the food industry. For example, tests now being conducted may result in better cups of coffee and better flavored strawberries. The volatile substances which make flavor are being analyzed to learn their true nature. The protein content of canned meats, cereals, and like substances will be specified more accurately if current experiments with nuclear magnetic resonance work out. Irradiation as a means of sterilization and of preserving foods for indefinite periods is "promising," but there is felt to be need for additional research programs in this field. Ultrasonics is believed over-promoted and under-developed. (However, speakers agreed this form of food processing by high frequency sound waves could be applied to such food problems as extracting flavors from vanilla and hops for beer production. Other uses which have been publicized may be economically feasible after additional research.) Copies of the *Proceedings* of this first international meeting of its kind are available at $5.00 per copy by addressing Mr. C. W. Smith, Southwest Research Institute, 8500 Culebra Rd., San Antonio, Texas.

◆ ◆ ◆

Southern Utilization Research Branch of the USDA Agricultural Research Service is seeking additional scientists for research to improve utilization of Southern farm crops. The Branch's research program includes fundamental and applied research in the chemistry and utilization of cotton, vegetable oils, fatty acids, terpenes, and resin acids. The program

offers opportunities for chemists, biochemists, physicists, and cotton technologists. Vacancies at the Southern Branch's Southern Regional Research Laboratory, New Orleans, carry entrance salaries ranging from $3670 to $7570 a year. Persons interested should apply to 8th Civil Service Region, 1114 Commerce St., Dallas, Texas. For further information about career opportunities at the Southern Branch, write Dr. C. H. Fisher, chief, Southern Utilization Research Branch, 1100 Robert E. Lee Blvd., New Orleans 19, La.

CMI Safety Awards were presented to representatives of six can manufacturing companies at the C M I Board of Governors meeting in New York City, March 5. Receiving engraved plaques for plants recording no disabling injuries during 1955 were the following, standing left to right: Mr. Chas. B. Stauffacher, vice president, Continental Can Co.; Mr. Wm. C. Stolk, president, American Can Co.; and Mr. E. B. Webster, vice president, Crown Cork & Seal Co., Crown Can Division. Seated left to right: Mr. Ralph C. Rosecrance, president, J. L. Clark Mfg. Co.; Mr. Albert E. Heekin, Jr., president, Heekin Can Co.; and Mr. Elliot Congleton, vice president, B. T. Babbitt, Inc.

"Perspectives in Food Technology," offered by Massachusetts Institute of Technology, June 18–29, 1956, will devote particular attention to some 15 aspects of modern food technology, which will be presented by means of lectures, demonstrations, and class participation. For information, write Office of the Summer Session, MIT, Cambridge, Mass.

Atlas Powder Company, Wilmington, Del., will award eight $1000 college scholarships again this year, Mr. Ralph K. Gottshall, president, has announced. The grants will go to students who will be seniors during the 1956-57 college year, majoring in chemistry or any branch of engineering. Winners of the awards will be announced May 15. The program, in which 38 colleges and universities have been invited to participate this year, will be administered by the Atlas committee on scholarships, headed by Dr. Thos. Kennedy, the company's director of industrial and public relations.

Announcement of the Second Annual Fatty Acid Award ($500) administered by the American Oil Chemists' Society has been made by Chairman H. C. Black. This award to degree candidates and recent graduates in colleges is given for papers or theses relating to fatty acids and their application. Entries will close August 1, 1956, and winner will be announced September 24. Write Fatty Acid Award Committee, A. O. C. S., 35 E. Wacker Dr., Chicago, Ill.

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Poultry with its freshness guarded by Aeronize, the antibiotic process, now is available in market areas from the East Coast to California. American Cyanamid Co., developer of Aeronize, says the process is already in use in some of the largest poultry plants in the country. Sold to processors under a franchise agreement in order to insure that it is used only in those plants which maintain high standards of sanitation, the process can be applied effectively only to fresh-killed poultry. A solution of Aeronize is added to the ice-slush in the chill tanks where poultry traditionally are cooled at the end of the processing line. Only trace amounts of Aureomycin are contained in Aeronize. What little may remain of the antibiotic by the time the bird reaches the consumer is destroyed by heat in less than ordinary cooking time. Its usefulness as an agent for preserving freshness of perishable foods has been certified by the USDA.

◆ ◆ ◆

An improved line of refrigerated incubators which provide easier controls and more constant temperatures has been introduced by Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill. Principal feature is location of heating controls and dials on outside of door, enabling operators to perform all adjustments (from 5° to 50° C.) without opening the door, thereby eliminating temperature fluctuations. Thoroughly insulated and porcelain enameled throughout, it will hold 120 bottles of 190-ml. size or 105 bottles of 300-ml. size. Price is $475.00.

◆ ◆ ◆

A dry land adaptation of a Cyclotherm Marine Steam Generator makes it possible to obtain 5000 pounds steam/hour from an over-all floor area of 8′ by 7′. This makes it possible to obtain 150 h.p. in less than half the space required for the average package steam generator. The boiler modulates over an extremely wide range with an exceptionally high efficiency. Designed by Cyclotherm Division, National-U. S. Radiator Corp., Oswego 11, N. Y., to rigid government specification, this boiler is completely reliable and efficient under the most severe variations in operating conditions. It is completely electronically controlled.

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A high speed electric girth strapping machine capable of strapping, bundling, or reinforcing on an assembly-line basis, now is available from Permacel Tape Corp., New Brunswick, N. J. Designated the Permacel 401 electric girth strapper, the machine can apply in excess of 700 straps per hour, while at the same time automatically compressing material to be strapped. The complete wrap is applied automatically. Packages up to 12″ by 12″ with no limit on length can be handled. Minimum package size is approximately 4″ by 4″. The 401 is adjustable to handle either hard or soft materials; square or irregular-shaped units. It is powered by a 110-volt, single-phase A.C. ¾ h.p. electric motor. Physical dimensions are 70″ high, 57″ wide, and 40″ deep. The unit weighs approximately 900 pounds. Price is $3,500, F.O.B. point of origin. It also is available under a special lease arrangement.

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Simple, fast operating procedures have been built into a new Abbe-3L Refractometer introduced by Bausch & Lomb Optical Co., 653 St. Paul St., Rochester, N. Y. In one minute, the operator can load, light, and look into the instrument to obtain the refractive index of liquids, dissolved solids, and some opaque solids. It will be particularly useful as a quality control tool in the food, chemical, and petroleum industries. Design innovations make it especially useful for production line operation by non- technical workers. Refractive index range is 1.30 to 1.71; solids scale reads 0% to 85%. Price is $695.00.

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A new line of LQ600-200 Bronze Globe Valves, rated at 200 pounds steam pressure and at 400 pounds water, oil, and gas pressure, has been announced by Lunkenheimer Co., Box 360, Cincinnati 14, O., as answering the need for a higher-pressure, throttling globe valve. Wear- and corrosion-resistance characteristics are identical with those established by the original LQ600 bronze valve which, following 5 years of industry-wide tests, is recognized as the most advanced valve development in years.

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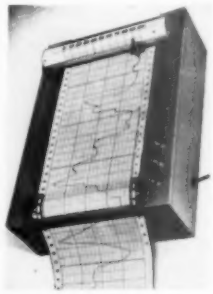
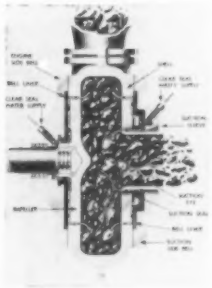
This new, portable, low cost strip chart recorder operates on a self-balancing potentiometer principle. With appropriate sensing devices, it will record temperature, speed, light, pressures, resistance, motion, or any variable that can be represented by a D. C. millivolt signal within its range. Design features include rectilinear tracings, 100 MV full scale, high input impedance, excellent reproducibility, high stability, 1% accuracy, faultless vertical or horizontal ink writing, high torque, servo motor, 5″ pen travel, synchronous motor paper feed, sprocket-driven chart, table or wall mounting. The instrument is 6″ high by 9½″ wide by 14″ long, and weighs 15 pounds. Price is $291.00, F.O.B. Chicago. Available from C. H. Stoelting Co., 424 N. Homan Ave., Chicago 24, Ill.



An improved line of centrifugal-type pumps designed for transporting mixtures of abrasive materials such as ash, slag, and fly ash from power plants and coke from petroleum plants is announced by The Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa. Known as the Hydroseal line, these pumps are available in two types and many sizes. One type employs rubber, neoprene, or other synthetic lining, and is suitable for pumping fine solid materials, especially where resistance to chemical action is important. A second type employs hard metal alloy wearing parts, and is suitable for handling sharp-edged solids that would tend to cut the softer, non-metallic linings. The pumps employ the Hydroseal principle to achieve high efficiency and extremely low maintenance, even under the most adverse pumping conditions. A simple change of V-belt drive ratio adapts the same pump to a wide range of capacities and heads.



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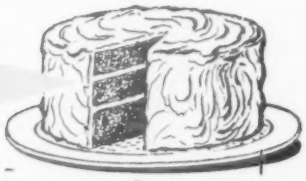
A new kit of presterilized expendable components has been developed to apply the MF® Millipore Filter membrane to a variety of microbiological analyses. The membrane, which reduces bacteria to its surface, is sealed in a sterile plastic unit which is both a filter holder and an incubation, or petri, dish. The kit is designed to meet the problem of bacteriological water testing under field conditions, and to eliminate the shipment of bottled water samples—long recognized as a source of gross error and considerable expense. Write Millipore Filter Corp., 36 Pleasant St., Watertown 72, Mass.

◆ ◆ ◆

Data on **two new closing machines** has been revealed by American Can Co., which designed and manufactures the rapid-fire equipment. The thousand-can-a-minute 210-8R is a self-contained can-revolve closing machine for double-seaming round cans, and is equipped with 8 seaming units in a revolving cage. It can be adapted for steam flow closure and gas flow closure, and can readily be arranged for close hook-up to most fillers to provide smooth can transfer. It is equipped with change parts that can easily be removed and replaced to permit closing of cans with varying heights and diameters. The other closing machine, the 410-6R2, can close up to 600 round cans per minute. It has 6 seaming units mounted in a revolving cage and can be used for steam and gas flow closing pro-

FINE FLAVOR

CAKES

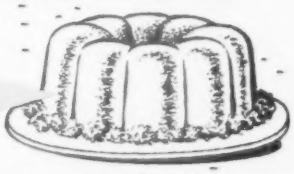


FORMULATIONS

PIE FILLINGS

FOR THE FOOD

GELATINS



INDUSTRY.....

PUDDINGS

FRIES & FRIES

flavors

Developing new and distinctive flavors or supplying established ones are equally important at Fries and Fries.

Our modern flavor laboratories are staffed with highly skilled chemists and technicians who have helped perfect the flavorings of many fine products found on every supermarket shelf.

Your inquiry will be given prompt attention and treated in strict confidence.

MANUFACTURING CHEMISTS
FRIES & FRIES
INC
CINCINNATI
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NEW YORK • 418 E. 91st St. • SA 2-2260
CINCINNATI • 110 E. 70th St. • VA 1-7200

cedures. It will close cans ranging from 202 to 404 in diameter, and 108 to 708 in height.

◆ ◆ ◆

POLY-ROCK floor surfacing, claimed to be more resistant to acids, oils, solvents, and water than any material known, is offered by Plant Maintenance, Inc., 623 Green Rd., Cleveland 21, O. The product contains no asphalt, cement, latex, or other similar ingredients. It is produced in a non-slip form and withstands considerable abrasion equal to most concrete surfaces. Even though applied in a thin layer by trowel, its toughness in protection of the floor base is stated to be outstanding. An additional feature is its speed and ease of application without expensive floor preparation, equipment, or lengthy shut-down period.

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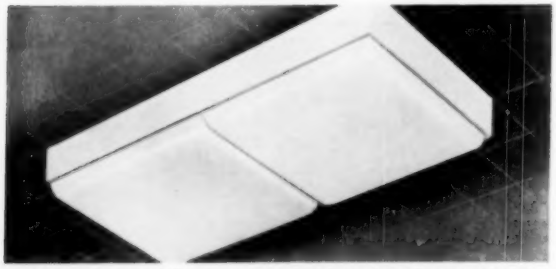

This is "Color Matcher," a new fluorescent lighting unit that provides the equivalent of natural light entering a North skylight at high noon—the ideal illumination for precision color tasks. Providing a light of the best Kelvin temperature (7500°) for exacting color comparison, the unit is ideal for fruit and vegetable inspection and grading. Manufactured by Duro-Test Corp., North Bergen, N. J.

◆ ◆ ◆

A practical new device that serves a dual purpose, both as a **tank sterilizer and as an insect eradicator,** is offered by Super Mfg. Corp., 29 N. Wacker Dr., Chicago. Super Air Sanitizer is an effective method of spraying chlorine solution or other liquid disinfectants on the inside surfaces of milk, food, and beverage storage tanks, vats, kettles, and transport trucks. The apparatus consists of a one-quart capacity polyethylene bottle equipped with a 4-way spray head, and connected by rubber hose to an air compressor. The average treatment takes only one to 5 minutes. Sanitizer unit is sold separately or complete with a compressor and motor. A special directional spray also is available. Write for illustrated circular.

◆ ◆ ◆

Acme Industries, Inc., Jackson, Mich., has announced a **new line of Flow-Mizer cooling towers** in capacities from 15 through 100 tons. Features of the 1956 line of towers include stepped-up capacities and increased efficiency through incorporation of the new, advanced-design Acme-Pak. The Acme-Pak consists of a series of vertically-mounted steel plates that create ideal conditions for water evaporation and fast, efficient heat dissipation. Companion products to the new cooling towers are a line of new Acme evaporative condensers with many of the same features.

◆ ◆ ◆

Froslite, **a mold-inhibiting enamel,** contains a proven fungicide which reduces the tendency of mold and "rope" growth, making this product an ideal paint for interior use in bakeries, dairies, restaurants, flour mills, etc. When Froslite is applied as directed, mold will not grow on walls, in cracks or crevices, on moving equipment, or in food conveying machinery. The product, applied by brush or spray, dries quickly, free of any paint odor that might taint food products. In addition to preventing mold growth, Froslite also provides a brilliant and permanent white enamel finish that resists smoke and fumes and stands up under frequent washing.

◆ ◆ ◆

A new felt with many applications in wet and dry filtration, FEON filter felt combines high chemical and temperature resistance with very high bursting strengths, plus the filtering characteristics of a felt, at a cost approximately that of a wool felt. FEON Orlon withstands temperatures up to 300° F., has excellent resistance to strong mineral acids and oxidizing chemicals, is unharmed by most common solvents, oils, greases, and acid salts, and has fair resistance to weak alkalis. It is excellent for hot corrosive fumes. Since it contains no bonding resin, it may be used for any chemical or temperature problem where Orlon itself is recommended. Available as yard goods or tailored to fit any type of filtration or dust collection equipment.

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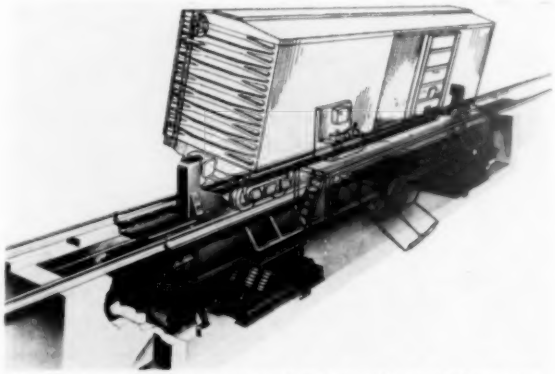

The Kar-Flo, manufactured by Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., takes a standard railroad boxcar weighing up to 150,000 pounds loaded, locks it in its grasp on a steel structure, and then, by means of a gentle oscillating, or rocking, motion of only 3" at the ends of the car, empties the load. The visible portion consists of a pair of rails mounted on a platform next to the receiving hopper, and an operator's platform with control center. The entire unit can be installed in a pit only 7' 3" deep. Write for Folder 2645.

◆ ◆ ◆

Designed to elevate loads up to 750 pounds for dumping heights in excess of 60", the Tubar Hi-Dump hydraulic dumper combines ruggedness, stability, and ease of operation with assured safety features. Available in portable or permanent models, it is equipped with telescopic or straight mast, and is equally efficient when powered by a 12-volt automotive battery or plug-in electric motor. Write Uhrden, Inc., P. O. Box 193, Dennison, O.

◆ ◆ ◆

An exclusive **new type of polyethylene film guaranteed pinhole-free** has been announced by Chase Bag

Co., 309 W. Jackson Blvd., Chicago 6, Ill. Pinhole-free polyethylene has wide application for bag, drum, box, and barrel liners. Write for complete information and samples of Polytex-phf.

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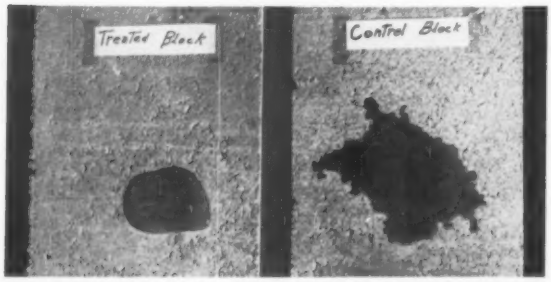

Concrete block at left has been treated with LOSORB, a low-cost moisture-proofing additive recently introduced by Pennsylvania Industrial Chemical Corp., Clairton, Pa. Addition of only 2% to 4% of the product reportedly permanently decreases by about 50% the permeability of concrete blocks, mortar, plaster, stucco, and concrete. LOSORB also minimizes crack frequency, makes the mix more plastic and easier working, acts as a lubricant in molding, minimizes shrinkage in curing, and prevents stucco from drying and cracking before the concrete base cures thoroughly. Industrial steel supported on concrete treated with LOSORB is permanently protected from corrosion by moisture absorbed from the earth.

◆ ◆ ◆

A new Norelco Flow Proportional Counter effectively detects and measures all elements down to and including magnesium (#12), is extremely sensitive, has a high counting rate exceeding 60,000 counts per second for soft radiation, and has excellent reproduction qualities, according to announcement by Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. The device is designed for use with the standard Norelco X-ray Spectrograph and Helium Attachment when the latter is required. A special harmless gas flows through the interior of the counter.

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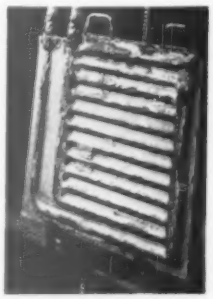
Platecoils, heat-transfer units designed to replace pipe coils in industrial processes requiring the application or removal of heat, now are available in several special alloys (Type 316 stainless steel, Monel, Carpenter 20, Hastelloy 'B' and 'C', and nickel) to extend their application in corrosive, highly acid, and other specialized industrial processes. They consist of 2 embossed metal sheets welded together to provide a preformed channel for the flow of heating or cooling media. Shown is a stainless steel unit that has served continuously for more than a year without requiring cleaning. Write Tranter Mfg., Inc., c/o R. E. Jaqua, 101-111 Garden St., S.E., Grand Rapids 2, Mich.



(Continued on page 55)

HOW NEW AO HAND REFRACTOMETER CUTS COSTS

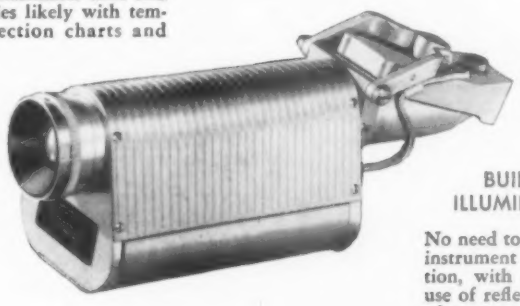
BUILT-IN TEMPERATURE COMPENSATION

Automatically eliminates time and error possibilities likely with temperature correction charts and thermometers.

Refractometric determinations are important in your pick or pack problems. The new AO Hand Refractometer will save you time, effort and money . . . here's how.

EASY-TO-READ SCALE

Unusually clear eyepiece image assures reading accuracy to 1/10 of one percent. Dividing line appears in sharp contrast even with dark colored liquids. Scale graduated in increments of 2/10 of one percent, has range of 0-30% sucrose (or degrees Brix).



BUILT-IN ILLUMINATION

No need to rely only on external light. Use instrument 3 ways; with built-in illumination, with external light source, and by use of reflection technique for analyzation of opaque solids.

ANYONE CAN USE IT

New AO Hand Refractometer is fast . . . low cost . . . requires no special training, no computations . . . direct reading scale gives immediate, accurate, on-the-spot determinations.

American Optical

Instrument Division
Buffalo 15, N.Y.

Dept. E 190

Please send full information on the new AO HAND REFRACTOMETER.

Name.....

Address.....

City..... Zone..... State.....

FELCOFIX*

powdered flavors

- Baked Goods
- Confections
- Desserts
- Dough and Flour Mixes
- Gelatin
- Ice Cream Powders
- Icings
- Medicines
- Pharmaceuticals
- Powders and Dry Mixes
- Puddings
- Soft Drink Powders
- Spice Mixes
- Tablets
- Vitamins
- Wafers

Felton's complete line of FELCOFIX powdered flavors offers you the best answer to the problem of permanently flavoring all kinds of dry, semi-dry or powdered products . . . completely eliminating that old shelf-life bugaboo!

These outstanding flavors are supplied as dry, perfectly homogeneous powders that remain fresh, true and delicious even when used in mixtures containing acids, sugars and other reactive ingredients.

Their concentration and lasting power are equally amazing, and result in economies that are important to your profits.

It will pay you to try our FELCOFIX flavors without delay!

Write now for Samples of these amazing new **FELCOFIX*** locked-in **FLAVORS**

FLAVORS • ESSENTIAL OILS • AROMATICS

FELTON CHEMICAL COMPANY, INC.
599 Johnson Ave., Brooklyn 37, N. Y.

*FELCOFIX is a trade mark of Felton Chemical Co., Inc.

PLANTS: BROOKLYN, N. Y. • LOS ANGELES, CAL. • MONTREAL, QUE. • VERSAILLES (S & O) FRANCE
SALES OFFICES: ATLANTA • BOSTON • CHICAGO • CLEVELAND • PHILADELPHIA • ST. LOUIS • TORONTO

(Continued from page 53)

Recently introduced by E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y., is a **handy, inexpensive alkali and acid-proof pump** called EMSON Siph-O-Pump, which permits the pouring of acids and other liquids without lifting or tilting the container. Besides the obvious advantage of safety, the firm says the unit permits far more control and accuracy in dispensing dangerous or expensive liquids in that Siph-O-Pump has a triple action—it pumps, it stops, and it siphons back in the event of over-filling.

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Some of the foods that can be packed and cooked in the new boilable transparent bags produced by Standard Packaging Corporation's Flex-Vac Division are, top row, left to right: vegetable soup, beef stew, tomato soup, spaghetti sauce, corn on the cob. Middle row: shrimp, sausage, carrots, frankfurters. Front row: scallops, butterfly shrimp. Advantages claimed for the Flex-Vac pouches, employing Polyester film by Du Pont and Polyethylene film by Visking and Olin Industries, are true and natural flavor, virtually no vitamin or nutrient loss, complete elimination of cooking odors, no appreciable loss of weight during cooking or heating, and no utensils to be washed. The firm is located in Clifton, N. J.

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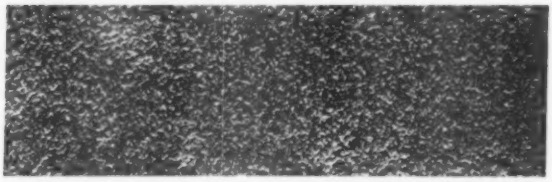

Top photo shows spray-dried skim milk particles, enlarged 8 times, while beneath is an actual photograph of agglomerated particles, enlarged 8 times, after passing through the new Instantizer, recently developed by the Dairy Equipment Division of Blaw-Knox Co., Mora, Minn. Clustering of particles reportedly permits rapid dispersal of powdered foods in water. The machine is effective on nonfat milk solids, whole milk solids, chocolate milk, and many other types of homogeneous blends or dry mixes. Bulk density of nonfat milk powder decreases about 50% from an average of 65 to 70 grams per 100 cc. to about 35 grams. The unit uses approximately 100 pounds of steam per hour; 2 connected electrical hp., and compressed air at 60-80 p.s.i. Production flows at the rate of 750 pounds per hour of instantized powder ready for packaging, based upon nonfat milk production figures. It will handle powder directly from a drying process or from storage.

. . . *the literary corner*

A wide range of possible applications for Epolene, a new line of polyethylene waxes developed by Eastman Chemical Products, Inc., Kingsport, Tenn., is suggested in a brochure for formulators and manufacturers of wax-containing industrial and consumer products. Important physical properties of the 2 types of Epolene, emulsifiable (E designation) and non-emulsifiable (N designation), are listed in the brochure along with comprehensive tables of their compatability with other synthetic waxes, natural waxes, resins, and dyes. The characteristics of Epolene-fortified paraffin are described in a series of graphs.

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A research report released by Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill., reprints this firm's presentation on salt as a margarine ingredient as presented at the Second Annual Margarine Research Symposium. The report presents data showing chemical and physical composition of available margarine salt, effect of impurities in salt on flavor and keeping qualities of margarine, and quality control methods useful in evaluating margarine salt quality.

◆ ◆ ◆

Proportioneers Chem-O-Shot Model 1920, a positive displacement chemical feeder for controlled injection of sterilizing agents for bottle washing in food and beverage plants, is described in Bulletin 1920, available from Proportioneers, Inc., 345 Harris Ave., Providence 1, R. I., or the national distributors, Klenzade Products, Inc., Beloit, Wis.

SIX DECADES
OF SERVICE TO
FOOD TECHNOLOGISTS

60 years of specialized experience in the manufacture of powdered vanilla products

David Michael has long since mastered the special skills and techniques to create new and highly individual flavorings to fill any specific need, and have been the acknowleged leader in the vanilla field for 60 years.

Let us develop a custom-made flavor for your product in our laboratories and testing kitchen. Research is our keynote—let it work to your advantage!

DAVID MICHAEL & CO., INC.
3743-63 D Street • Philadelphia 24, Pa.
Suite 2204 • 203 N. Wabash Ave., Chicago 1, Ill.

CANADA
DAVID MICHAEL & CO., LTD.
801 St. Clarens Ave., Toronto

Easy defeathering and better bloom are advantages gained by use of Oakite Composition No. 53 in the poultry-scalding bath, according to a Service Report recently published by Oakite Products, Inc., 157 Rector St., New York 6, N. Y., manufacturers of cleaning and sanitizing compounds for the poultry industry.

◆ ◆ ◆

The story on the several models of Royson Identicharts — automatic devices that print identifying marks on strip charts from a remote point to show the time or in what sequence conditions occur during process, test, or control work — is presented in a 4-page, illustrated bulletin available from Royson Engineering Co., Hatboro, Pa. Described are Model RI-1 that prints up to a 6-digit serial number, Model RI-2 that prints date and time to the nearest minute, and Model RI-3 that prints numbers or letters selected by the operator from a remote point.

◆ ◆ ◆

How industry is cutting costs, saving time, and increasing sales with photography is described in a new 16-page booklet on in-plant industrial photography released by Graflex, Inc., 154 Clarissa St., Rochester 8, N. Y. The case history booklet, "Industry Cuts Costs with 'In-Plant' Photography," cites successful applications of photography to solve sales, manufacturing, engineering, and design problems. Both large and small companies are included in the case histories. Request on company letterhead.

◆ ◆ ◆

How ten different organizations, each in a different line of business, are saving money with P-A-X, the privately-owned, rent-free dial telephone system used exclusively for "inside" calls, is explained in 12-page booklet, "10 Ways to Cut Costs with Inside Telephones," prepared by Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.

◆ ◆ ◆

A high-capacity, volumetric, chlorine gas feeder which accurately controls and meters chlorine gas under vacuum (in the dry, non-corrosive state) to produce and deliver chlorine-water solution to the point of application (at rates up to 8,000 pounds per 24 hours maximum, with a standard meter range of 1 to 10) is described in 4-page Bulletin 840-J8A issued by Builders-Providence, Inc., a division of B-I-F Industries, Inc., Providence, R. I.

◆ ◆ ◆

Bulletin 928, "The Corrosion Resistance of Pfaudler Glassed Steel to Acid Solutions," (including nitric, acetic, sulphuric, hydrochloric, and phosphoric acids) is offered by The Pfaudler Co., Rochester 3, N. Y.

◆ ◆ ◆

The complete line of Torit cabinet cloth filter and cyclone separator type dust collectors is pictured and described in a 16-page catalog issued by Torit Mfg. Co., 287 Walnut St., St. Paul 2, Minn. Included are reasons why dust collectors are essential to industry, how unitized collectors save money, and how they can be used.

The first of a series of reprints and publications on coffee, resulting from research projects sponsored by The Coffee Brewing Institute, Inc., has been released by the Institute, 551 Fifth Ave., New York 17, N.Y. The initial booklet, entitled "The Effect of Water Impurities on the Flavor of Brewed Coffee," appeared originally in *Food Research*, Vol. 20, 598 (1955). The water study was conducted in the Department of Food Technology at MIT by E. E. Lockhart, C. L. Tucker, and M. C. Merritt.

◆ ◆ ◆

A new series of bucket elevators called "Buckels" for lifting vertically bulk materials is described in a catalog available from The Bucket Elevator Co., 360 Springfield Ave., Summit, N. J. The catalog illustrates an exclusive Buckel feature—one entire side of the conveyor elevator casing is removable in conveniently handled panels for quick and thorough cleaning. Standard Buckels are manufactured in all stainless steel as well as carbon steel construction, and in 5 basic models for elevating bulk materials from 4' to 50', and to handle capacities from zero to 30 CFM.

◆ ◆ ◆

The *Proceedings* of the Fourth Annual Meeting of the Agricultural Research Institute, held in Washington, D.C., October 17-18, 1955, are available upon writing Agricultural Research Institute Office, 2101 Constitution Ave., N.W., Washington 25, D.C.

◆ ◆ ◆

"The Future for Industrial Research," a speech given at the recent Ninth Annual Conference on the Administration of Research, Northwestern University, by Mr. E. D. Reeves, executive vice president, Esso Research and Engineering Co., has been published in attractive format by Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo. The complete *Proceedings* of the Conference is available from New York University Press, Washington Square East, New York 3, N.Y., at $4.00.

◆ ◆ ◆

The *Proceedings* of the August 1955 International Conference on Peaceful Uses of Atomic Energy, held in Geneva, Switzerland, and attended by approximately 1,200 scientists from 72 nations is available in a 16-volume set. Price of the individual volumes ranges from $5.00 to $10.00. For information, write Sales and Circulation Section, United Nations, New York City, or Sales Section, United Nations, Geneva, Switzerland.

◆ ◆ ◆

New 6-page Bulletin H-55 on use and selection of Industrial homogenizers has been prepared by Manton-Gaulin Mfg. Co., 44 Garden St., Everett, Mass. It shows features of the Gaulin Homogenizer, cutaway views of the construction, and specifications. There is a capsule "Theory of Homogenization" and information on the various types of products which can be handled. Also included is a description of the 5 special Gaulin valve designs for handling fluid, viscous, slightly abrasive, and very abrasive products. The firm also announces availability of bulletins P-55,

describing the Gaulin Horizontal Triplex Pump, and S-M-D-55 on the new Gaulin Sub-Micron Dispenser.

◆ ◆ ◆

A 12-page brochure from Canada, entitled "Entomology Laboratory Biological Control Investigations," sets forth that nation's program of controlling destructive insect pests and noxious weeds through use of parasitic and predacious insects, and insect disease organisms. Officer-in-charge of the Laboratory, located at Belleville, Ontario, is Dr. B. P. Beirne. Further information and literature on this and other phases of investigative work of the Canada Department of Agriculture may be obtained by writing to Dr. K. W. Neatby, director, Science Service, Science Service Bldg., Carling Ave., Ottawa, Ontario, Canada.

◆ ◆ ◆

A colorful, 6-page booklet on the Scotsman Super Flaker line of crushed ice machines is being offered by American Gas Machine Co., Division of Queen Stove Works, Inc., Albert Lea, Minn. The booklet covers the complete line in 8 different capacities ranging from maximum output of 200 pounds to 2,000 pounds per day. "Automatic Storage" models with self-contained stainless steel bins are shown, as well as "Continuous Flow" types that produce ice direct to bins, coolers, or other containers.

◆ ◆ ◆

The text and illustrations of a recent talk given before the Instrument Society of America on factors governing accuracy in controlled volume pumping are presented in bound Technical Paper No. 65, available free of charge from Milton Roy Co., Station M, 1300 E. Mermaid Lane, Philadelphia 18, Pa. Test procedures and results of separate investigations into metering accuracy are recorded. The firm also offers Technical Paper No. 64, describing several practical systems for process and waste water treatment utilizing controlled volume pumps to meter chemicals and additives.

◆ ◆ ◆

The *Proceedings* of the Ninth International Congress of Refrigeration held in Paris, August 31-September 8, 1955, are announced as available. For information on price and other details, write Institut International du Froid, 177 Boulevard Malesherbes, Paris-17e, France.

◆ ◆ ◆

From American Meat Institute Foundation, 939 E. 57th St., Chicago 37, Ill., comes word of the availability of reprints of the following papers by Institute staff members: "The 'Minute' Streptococci: Further Studies on Their Nutritional Requirements and Growth Characteristics on Blood Agar;" "Reciprocal Replacement of Oleic Acid and CO_2 in the Nutrition of the 'Minute' Streptococci and *Lactobacillus leichmannii*;" " Folic Acid Nutrition of the 'Minute' Streptococci;" "A Study of the Methylene Blue and Oxygen Inhibition of Pyruvate Oxidation by *Micrococcus pyogenes* var. *aureus*;" "Tellurite-Glycine Agar: A Selective Plating Medium for the Quantitative Detection of Coagulase-Positive Staphylococci;" "Vitamin Nutrition of the Staphylococci with Special Reference to Their Biotin Requirements;" and "Significance of Streptococci in Canned Hams."

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Write to Dr. H. R. Kraybill, vice president and director of Research and Education of the Foundation.

◆ ◆ ◆

A new, 16-page issue of its "LAB-ORATORY" and an enlarged 1956 edition of its Chromatography Catalog are announced by Schaar & Co., 754 W. Lexington St., Chicago 7, Ill. New catalog items shown for the first time include Tube Set-Ups, Fraction Collectors, Electric Desalter, Solvents, Chemical Adsorbents and Ion Exchangers, Distillograph, and Chromatogram Attachments for Spectrophotometers.

◆ ◆ ◆

A new free Service Bulletin, "The Question of Chronological vs. Physiological Aging in Industry," published by Occupational Health Institute, Inc., 6 E. 39th St., New York 16, N. Y., is designed to help management and labor reach a practical solution of the significant problems posed by the increase in the life span of today's workers.

◆ ◆ ◆

More than 7,000 trade, business, professional, scientific, labor, social welfare, fraternal, etc., organizations are listed in the first edition of the *Encyclopedia of American Associations*, price $15.00, published by Gale Research Co., 247 Kenworth Rd., Columbus 14, O.

. . . meeting hall and conference room

Atlantic City's Hotel Traymore will play host to the 47th Annual Convention of the Flavoring Extract Manufacturers' Association of the United States on

May 13-16, 1956. Included on the program will be a report of the Scientific Research Committee by Dr. A. S. Wendt, report of the Food Additive Committee by Mr. Harold Janovski, a talk on Spray-Dried Flavors by Mr. J. M. Wenneis, and a talk on the Stabilization of Citrus Oils and Beverages by Dr. David Jorysch. All of the foregoing are members of IFT. Chairman of the Convention is IFT member Robert Krone of Fritzsche Brothers, Inc.

◆ ◆ ◆

The non-power industrial applications of nuclear energy will be explored at an Industrial Nuclear Technology Conference at the Museum of Science and Industry in Chicago on May 15-16, 1956. Some of the nation's leading nuclear scientists will participate in the meeting, sponsored jointly by Armour Research Foundation of Illinois Institute of Technology and *Nucleonics* magazine. The opening day will be devoted to discussions of radiation sources and chemical applications. The second day's program will deal with biological applications, industrial applications, and instrumentation. Write Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

◆ ◆ ◆

An International Meeting of Fish Processing Technologists, organized by the FAO Interim Committee on Fish Handling and Processing, will take place at Rotterdam, The Netherlands, from 25 to 29 June, 1956. Although invitations have been issued officially to the 72 Member Governments of FAO to send delegates, the meeting will be open to any fishery technologist who wishes to attend. Featured will be a Symposium on the Chilling of Fish which will deal with use of antibiotics, bacteriostatic ices and dips, brine cooling, sea water ice, scale and crushed ice, and fresh fish quality assessment, using organoleptic and objective methods. Fishery technologists who wish to attend the meeting should notify the secretary of the Interim Committee, Dr. Ernest Hess, chief, Technology Branch, Fisheries Division, Food and Agriculture Organization of the U. N., Viale Delle Terme di Caracalla, Rome, Italy.

◆ ◆ ◆

"Unit Processes in the Fatty Oil, Soap, and Detergent Industry" will be the theme for the eighth annual short course sponsored by the American Oil Chemists' Society at Purdue University, Lafayette, Ind., July 16-20, 1956. Registration fee for the course is $50. Rooms will be available at the Purdue Memorial Union Building on a daily rate basis. Registration forms and further information can be obtained from the Society's office, 35 E. Wacker Dr., Chicago 1, Ill. Advance registration is required.

◆ ◆ ◆

The annual technical short course conducted by St. Louis Univeristy for the Society of Industrial Packaging and Materials Handling Engineers will be held in St. Louis, October 22-25, 1956. The short course will be held in the city's downtown Kiel Auditorium in conjunction with the annual Protective Packaging and Materials Handling Competition and the Industrial Packaging and Materials Handling Exposition, both also sponsored by SIPMHE, which will be held in the same building. Dean Stephen W. Vasquez of the School of Commerce and Finance of St. Louis University is coordinator of the short course. For information, write G. Cornwall Spencer, 30 N. LaSalle St., Chicago 2, Ill.

. . . *building up and branching out*

Almost complete recovery of current records was made from the charred ruins of the Curtiss Candy Company office building, destroyed by fire February 22. Losses to the building, and all equipment were estimated at $1,250,000. The firm's Chicago plants continued in full production and maintained shipments on schedule.

◆ ◆ ◆

Consolidated world sales of Abbott Laboratories increased 4% to reach a record high of $91,706,000 in 1955. Earnings increased 11% to $9,683,000, or $2.48 per common share. Abbott's 1956 expansion program, calling for expenditures of $3,500,000, includes a new chemical manufacturing building at the North Chicago main plant, a new manufacturing plant in Argentina, expansion of the Montreal manufacturing plant, and a new sales and warehouse unit at Toronto.

◆ ◆ ◆

Plans for erection of the world's largest pyrethrum-extraction plant outside of the U. S., in Nakuru, Kenya, Africa, have been laid before American and European manufacturers of equipment, it was announced by African Pyrethrum Development, Inc., 65 Pine St., New York City. Capacity of the plant is expected to be 2,500-3,000 tons of flowers a year, and is planned for future expansion. The extracted product is pyrethrin, an active agent in the daisy-like blooms which, when blended into aerosol and other sprays, forms an insecticide harmless to warm-blooded life. The U. S. currently imports about 65% of total African production.

◆ ◆ ◆

An offering of 194,155 shares of common stock of Riegel Paper Corporation to current stockholders was announced recently by Mr. John L. Riegel, board chairman. At the same time, the firm is making an underwritten public offering of $6,000,000 of 3⅞% debentures. Purpose of the issue, expected to add almost $11,500,000 to the general funds of the paper firm, is to permit expansion in pulp and paper-making facilities.

◆ ◆ ◆

Announcement of the formation of Whitman Laboratories was made recently following a meeting of the incorporators and stockholders in Norwich, N. Y. Whitman Laboratories will engage in the manufacture and sale of chemicals and food products, initially concentrating its activities in the industrial chemical field. The firm will act as exclusive midwestern, western, and southern sales agent for Beech-Nut Packing Company on vinyl acetate resins. In addition, Whitman will serve as national broker for Sheffield Chemical, Division of Sheffield Farms Co., Inc., on industrial caseins, and will represent nationally Chemo Puro Mfg. Corporation on industrial preservatives and chemicals. Officers of the new company, located at 11 S. Broad St., Norwich, are: John G. Brereton,

president and treasurer; Walter B. Kinney, vice president; and Elizabeth F. Brereton, secretary.

◆ ◆ ◆

A new subsidiary to handle its expanding flavor business has been established by Perry Bros., Inc., 61-12 32nd Ave., Woodside, N. Y., known primarily for perfume specialties and raw materials. The new Perbro Laboratories division of the firm will manufacture a wide line of essential oils and flavor bases for the pharmaceutical, beverage, and food fields.

◆ ◆ ◆

R. G. Moench & Co., Inc., manufacturers of industrial foods and chemicals, moved into their new office building on April 12. Their new address is: 89 Terminal Ave., Clark, N. J.

. . . *the human element*

Three investigators in the glycerine research field were honored at the January annual meeting of the Glycerine Producers' Assn. Top award of $1000 and honor plaque went to **Dr. Reed A. Gray,** Merck & Company plant physiologist who discovered that incorporating glycerine in streptomycin formulations increased absorption of the antibiotic by plants and enhanced its effectiveness against the common bacterial blight of beans. **Dr. Eugene P. Kennedy,** University of Chicago biochemistry professor, received second award ($300 and honor plaque) for his study of the biosynthesis of phospholipids, including the role of glycerine derivatives as precursors of these compounds. Third award ($200 and honor plaque) was won by **Dr. Karl H. Lauer,** University of Alabama chemistry professor, for a process using slaked lime in glycerine-water solutions to convert sodium sulfate into caustic soda.

◆ ◆ ◆

Fabian Bachrach

. . . the Ac'cent is on Hamilton

Mr. George B. Hamilton has been elected vice president in charge of the Ac'cent International Division of International Minerals & Chemical Corp., Chicago, succeeding Mr. J. R. T. Bishop, who died early this year. IFT member Hamilton, a dairy technology graduate of Iowa State College, joined International in 1947, and has been general manager of Ac'cent International since 1952. He has played a key role in the development and marketing of the product as a food seasoning.

◆ ◆ ◆

In a move signalizing expansion of its research activities, A. E. Staley Mfg. Co., Decatur, Ill., has appointed **Dr. Thos. L. Gresham** vice president in charge of research and development. Dr. Gresham, 49, who resigned as director of Organic Chemicals and Engineering Research for the B. F. Goodrich Company to accept the new post, is author of more than 20 technical publications and has patented 32 separate chemical processes.

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Dr. Bernard L. Oser, vice president and director of Food Research Laboratories, Inc., 48-14 33rd St., Long Island City, N. Y., has completed the task of editing the 1956 Directory of the American Council of Independent Laboratories, Inc. The 100-page volume, with book binding, includes scope sheets for 67 member laboratories and details of facilities and services of members. He is presently on a 'round-the-world trip, which will culminate with the late Spring meeting in Amsterdam of the International Vitamin Commission.

Oser . . . after editing for ACIL . . . a world cruise for Bernard L.

◆ ◆ ◆

Dr. Gerald Reed has been appointed director of research of Red Star Yeast and Products Co., Milwaukee, Wis., succeeding the late Dr. F. J. Rudert. Dr. Reed, a member of IFT, is a graduate in biochemistry of the Universities of Berlin, Munich, and Prague, and has been active in the U. S. food and pharmaceutical industry since 1938.

◆ ◆ ◆

The appointments of **Mr. C. F. Lausten** as general manager of the equipment division, and **Mr. R. B.**

(Continued on page 61)

FOR MEMBERS ONLY

DIRECTORY OF MEMBERS 1956

The Institute of Food Technologists

This Edition of the Directory is in Four Sections.

Section I lists alphabetically each member of the Institute followed by:

(a) Highest academic degree held
(b) Mailing address
(c) Organization with which affiliated
(d) Position or field of interest

Section II lists student members by schools

Section III lists companies and other organizations with which members are affiliated

Section IV lists all non-member subscribers to Food Technology

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INSTITUTE OF FOOD TECHNOLOGISTS
176 West Adams Street
Chicago 3, Illinois

(Continued from page 59)

Thompson as general manager of the general manufacturing department of American Can Company were announced recently.

◆ ◆ ◆

Mr. Jesse G. Heiges, with the firm since 1950, has been elected secretary and general counsel of Chas. Pfizer & Co., Inc., Brooklyn, N. Y.

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. . . Krum . . . from Nabisco to Zimco

Dr. Jack K. Krum has been appointed assistant technical director of Sterwin Chemicals Inc., 1450 Broadway, New York 18, N. Y. IFT member Krum, who will work with Dr. R. C. Sherwood, vice president and technical director, was research chemist for National Biscuit Company from 1952 until joining Sterwin.

◆ ◆ ◆

The Pfaudler Company, Rochester, N. Y., announces the following appointments: **Mr. Alton L. Gray,** with the firm since 1922, and most recently Rochester district sales manager, to assistant general sales manager; **Mr. Edgar N. Fox, Jr.,** to Rochester district sales manager; **Mr. Dewey R. Holcombe** to manager of the Chemical Equipment Sales Department; and **Mr. Rudolph A. Bender, Jr.,** to manager of the Brewery Sales Department.

◆ ◆ ◆

. . . a new hat for White Cap's White

Newly elected vice president in charge of sales for the White Cap Co., 1819 N. Major Ave., Chicago, is **Mr. Robert P. White,** previously sales manager for the firm's central and south-central territories. Replacing IFT member White in the latter post is **Mr. Jack Scanlon,** a White Cap sales representative since 1950.

◆ ◆ ◆

Mr. Frank N. Pond, formerly with Old Maltine Co., Fritzsche Brothers, and Dodge & Olcott, has been named sales manager of Dominion Products, Inc., Long Island City, N. Y.

◆ ◆ ◆

Appointment of **Mr. John B. Bowman** as vice president, Sales, and **Mr. Louis W. Schumm** as vice president, Manufacturing, were announced recently by Ekco-Alcoa Containers Inc. The new officers will be located at the company's new $5 million plant near Wheeling, Ill., as soon as the plant has been completed.

◆ ◆ ◆

Appointments announced by Beckman Instruments, Inc., South Pasadena, Calif., include the following: **Mr. Lee Cahn,** formerly chief project engineer, to product line supervisor for Infrared Spectrophotometers; **Mr. Phil Evans,** formerly assistant sales manager in charge of technical sales for Scientific Supply, Seattle, Wash., to sales engineer for Infrared Spectrophotometers; and **Mr. Michael S. Dayton,** recently product manager for flight reference systems with Lear, Inc., Grand Rapids, Mich. to sales manager of the company's Arga Division. The latter Division recently purchased the entire inventories of mechanical and electro-mechanical components manufactured by Belock Instrument Corp., New York City.

◆ ◆ ◆

Mid-West Metallic Products, Inc., 2100 Payne Ave., Cleveland, O., has announced formation of a material handling division with **Mr. T. R. Mutto** as manager. The firm will produce the entire line of aluminum shipping containers now being manufactured by the Mutto Mfg. Co., Canton, O. Mr. Mutto will continue as president and director of the latter firm, which makes aluminum safety spheres and other products.

◆ ◆ ◆

After an active association of over 40 years with Mellon Institute, Pittsburgh, Pa., **Dr. Edward R. Weidlein,** president of the scientific research organization, retired on March 31. He will remain on the Board of Trustees of the Institute and will be available in an advisory capacity in the administration of the Institute's research programs. His successor will be announced at a later date.

◆ ◆ ◆

Mrs. Janet Crawford Taylor has returned to National Cranberry Assn., Hanson, Mass., as home economics director.

◆ ◆ ◆

Dr. Jacques P. Sibeud, recently associated with Rhone-Poulenc, Paris, France, has been appointed manager of laboratories for Rhodia, Inc., New York City, manufacturer of aromatic chemicals and indus-

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

May 7-11	Sixtieth Annual Meeting of the Association of Food and Drug Officials of the U. S., New York, N. Y.
May 12-15	Annual Meeting of the National Independent Meat Packers Association, Palmer House, Chicago, Illinois
June 4-9	Ninth Annual Microbiological Institute, Purdue University, Lafayette, Indiana. Theme, "Know the Molds."
June 6-9	**Sixth Annual Convention of the Australian Sections of IFT, Ritz, Leura, N. S. W. Australia**
June 10-14	**Sixteenth Annual Meeting of the Institute of Food Technologists, Sheraton-Jefferson Hotel, St. Louis, Missouri**
June 18-22	International Congress on Food Distribution, Rome, Italy
June 18-29	Special Summer Program on Perspectives in Food Technology, Massachusetts Institute of Technology, Cambridge
June 20-22	The 52nd Annual Meeting of the National Macaroni Manufacturers, Wentworth-by-the-Sea, Portsmouth, New Hampshire
July 9-11	The Second Symposium on "Foreign Chemicals in Foods," Amsterdam, Holland
August 17-25	Tenth International Congress of Entomology, McGill University and the University of Montreal, Montreal, Canada
September 10	The Perkin Centennial, sponsored by the American Association of Textile Chemists and Colorists, Waldorf-Astoria, New York

trial reodorants. The firm recently moved to larger facilities at 60 E. 56th St.

◆ ◆ ◆

Mr. Raymond Stevens, a vice president of Arthur D. Little, Inc., Cambridge, Mass., since 1930, has been elected the research firm's third president in 70 years, succeeding **Dr. Earl P. Stevenson,** elected chairman of the board. Mr. Stevens currently is president of the Woods Hole Oceanographic Institution and chairman of the advisory board on Quartermaster Research and Development of the National Research Council. He is the author of the recently announced Lexington Plan to recruit more high school science teachers with the help of industry. Dr. Stephenson, with the company since 1919, succeeded the late Dr. Arthur D. Little as president in 1935. During his tenure, the business' dollar volume has expanded 40-fold. He is a member of the board of the National Science Foundation, of the council of the AAAS, and of the council of the National Planning Association. Arthur D. Little,Inc. recently acquired The Miner Laboratories, Chicago chemical consultants.

Fabian Bachrach

. . . good job expectancy for new ADL prexy Stevens

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Vulcan Containers Inc., Bellwood, Ill., has appointed **Mr. Gerald J. Fahey** its Greater Detroit area sales representative for the Vulcan line of steel shipping drums and pails. His address is 6432 Cass Ave., Detroit 2, Mich.

RECENTLY ELECTED MEMBERS OF IFT

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720 E. Grove St.
Ontario, Calif.

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Minneapolis, Minn.

Eldon K. Bacon
4120 Via Largavista
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Pelham Manor, N. Y.

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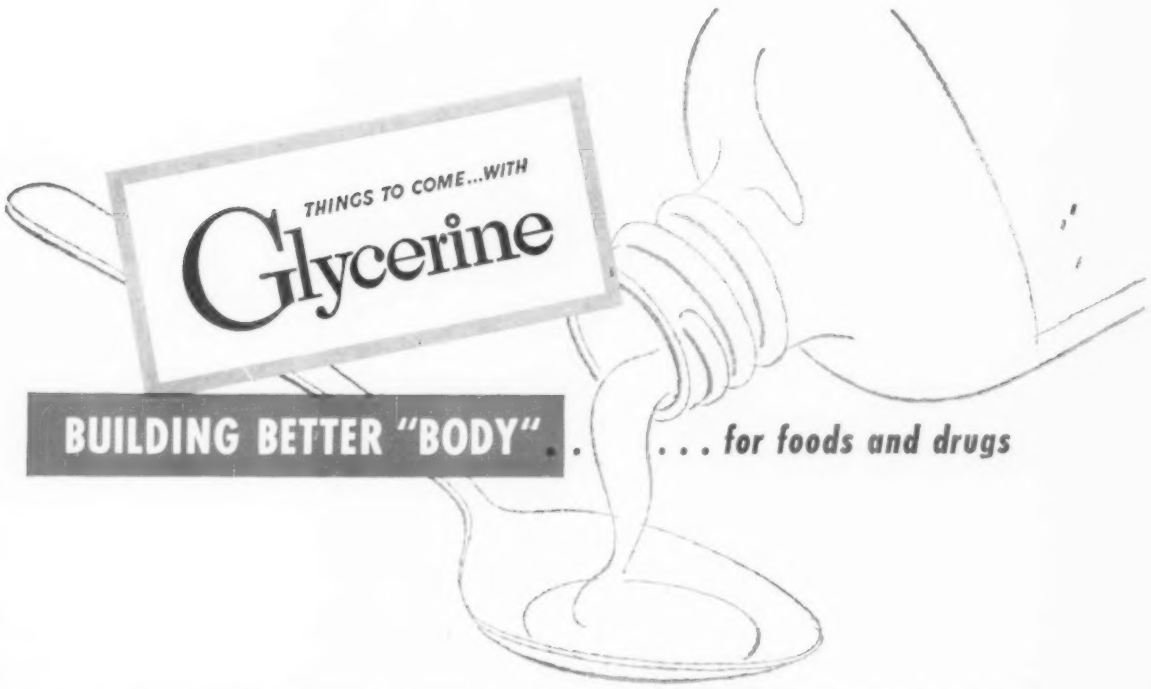

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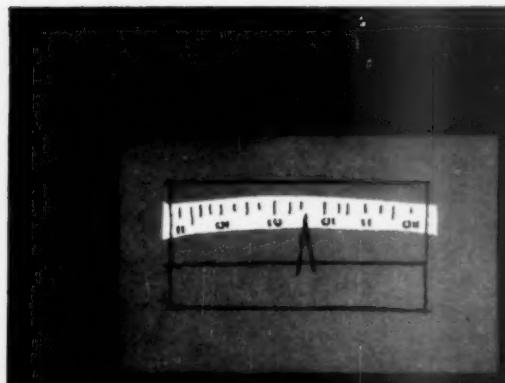

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